Forest Focus Monitoring Database System

EXECUTIVE SUMMARY REPORT 2003 LEVEL II DATA

Hiederer, R., T. Durrant, O. Granke, M. Lambotte,
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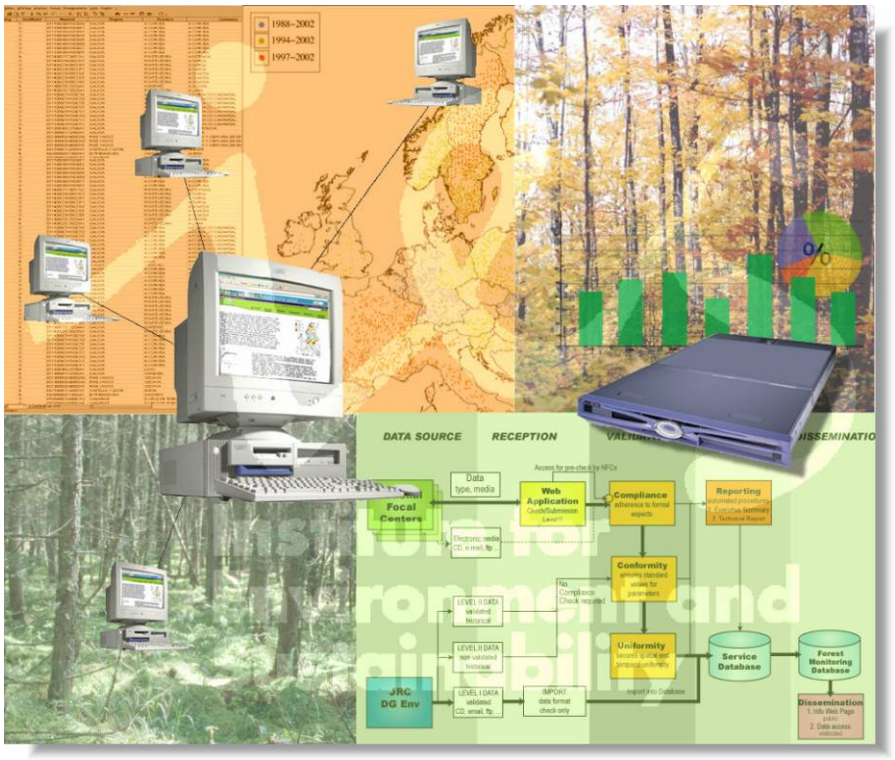

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List of Acronyms and Abbreviations

CODE	DESCRIPTION
ASCII	American Standard Code for Information Interchange
BFH	Federal Research Centre for Forestry and Forest Products Bundesanstalt für Forst- und Holzwirtschaft
BLOB	Binary large object
CLRTAP	Convention of the Long-Range Trans-boundary Air Pollution
dbh	Diameter at breast height
DAR	Data-Accompanying Report
DG AGRI	Agriculture Directorate General
DG ENV	Environment Directorate General
JRC	European Commission Joint Research Centre
DSM	Data Submission Module
EC	European Commission
EU	European Union
FFMDb	Forest Focus Monitoring Database
FIMCI	Forest Intensive Monitoring Coordinating Institute
ICP Forests	International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forests
IES	Institute for Environment and Sustainability
LM&NH	Land Management & Natural Hazards Unit
NFC	National Focal Centre
NSI	Nouvelles Solutions Informatiques s.a.
PCC	Programme Coordinating Centre
PDF	Portable Document Format
UN-ECE	United Nations Economic Commission for Europe
XML	Extended Mark-up Language

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

1 GENERAL INFORMATION

This *Executive Summary Report* for 2003 Level II data supplements the *Technical Report* for the same monitoring year. It presents a concise account of the data submitted and the results obtained from the checks applied for validating the data. Problems encountered with a general character and particularities with significant consequence on the overall project are also included in the report. For details and technical background of the data and the validation process the *2003 Technical Report* should be referred to.

1.1 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. The monitoring programme of air pollution effects is linked to the *International Cooperative Programme on Assessment and Monitoring of Air Pollution Effects on Forest* (ICP Forests). ICP Forests reports to the Working Group on Effects of the *Convention of the Long-Range Trans-boundary Air Pollution* (CLRTAP) of the *United Nations Economic Commission for Europe* (UN-ECE).

Countries participating in the scheme designate authorities and agencies as National Focal Centres (NFCs) submit annually to the Joint Research Centre of the European Commission (JRC) their observations made on the network of observation plots for intensive and continuous monitoring (Level II). For managing the data the JRC has implemented a Forest Focus Monitoring Database System. The system was developed and implemented 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.

1.2 Reporting

The objective of the reporting task is to provide a comprehensive account on the data provided for a given monitoring year in form of standardized documents. The main documents produced are the *Data Submission Report, Technical Reports* and the *Executive Summary Report*.

- *Data Submission Reports* present a detailed account of data submitted by NFCs to the Commission and includes the results from the compliance checks, which are generated during the process.

[1] OJ L 324, 11.12.2003, p. 1-8

- *Technical Reports* contain results and findings obtained from all data validation checks for a given monitoring year. Observations reported for a given monitoring year are contrasted with those from previous years. Developments ove time and differences between plots are investigated. Any specific areas of concern are described explicitly. Where appropriate measures to improve the data submission and their compliancy are proposed.
- The *Executive Summary Report* is published as a complement to the *Technical Report*. It combines a summary on data submission and results from the validation process. Specific attention is drawn to any problem found during data submission and peculiarities of the year are highlighted.

These reports are prepared separately for each monitoring year following the schedule for data submissions and the validation process.

2 DATA VALIDATION PROCESS

The validation of data submitted by NFCs forms the central activity of data processing and management. Its purpose is to ensure that the information stored in the system is transparent to any user and that it can be used in the evaluation of temporal and spatial trends. It should also allow the integration of the data with other data sources in more extensive thematic analyses. During validation the data are subjected to various checking routines. The routines are applied in succession with increasing degree of complexity of the checks performed.

2.1 Validation Checks

Data are validated based on the principle that it is not possible to identify the correctness of data, but rather that it is possible to identify the probability that data represent valid measurements or conditions. The methodology applied is a sequential grading of data using various characteristics and increasingly complex tests. A graphical overview of the validation tests is given in Figure 1.

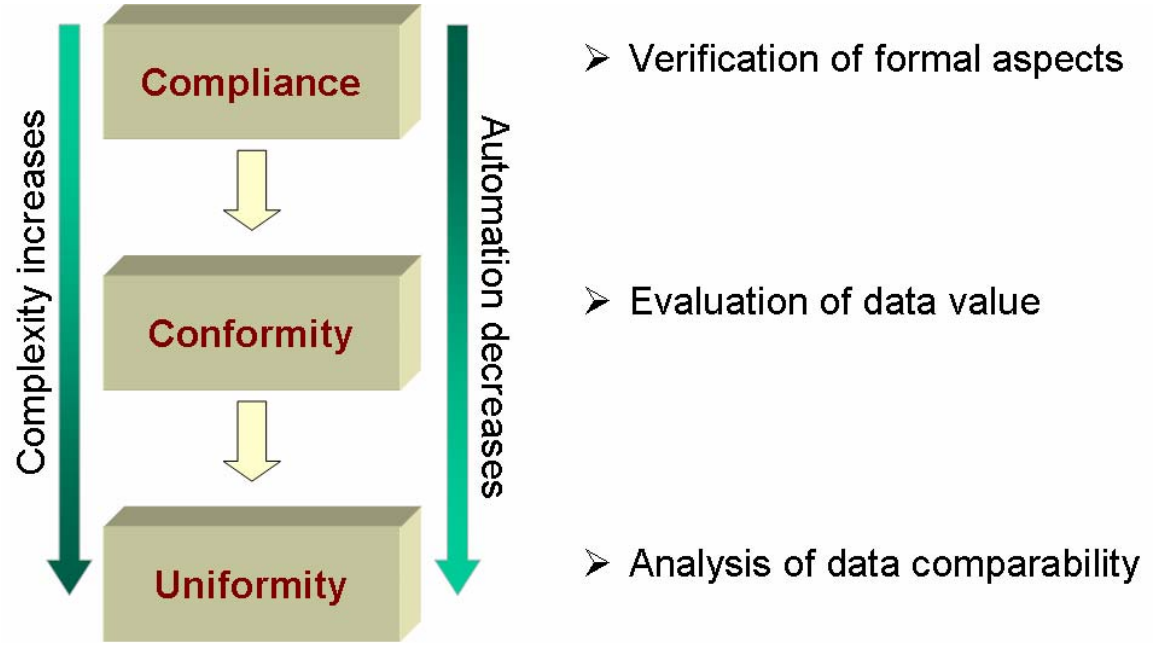

Figure 1: Sequential arrangement of Data Validation Tests

The validation process is based on the principle of evaluating the probability that a data value comprises an actual observation. It excludes impossible values, e.g. pH = 0, and indicates those, which do not correspond to expected conditions for further investigation. In addition, data consistency is tested by checking the constancy of static values (e.g. individual tree species, altitude) from year to year and logical continuity of the change of data collected (e.g. tree diameter, age).

2.1.1 Compliance Check

The tests applied for the Compliance Check verify if the submitted data comply with the formats stipulated in the data submission forms. The submission file format is based on the *Technical Specifications* documents issued by the JRC for each monitoring year. Also validated is if the values are admissible, e.g. in case of categorical parameters. Any deviation from the defined format will lead to an error or at least a warning message. In case a value fails a compliance test the whole survey cannot be further processed and an NFC will have to submit the survey with corrected values.

2.1.2 Conformity Check

The Conformity Check comprises a number of subtasks that are made after the submitted data have been subjected to compliance checks and have been loaded to the staging area of the processing database. The data are tested for

- being plausible either within expected general ranges (single parameter),
- depending on values of other parameters (multiple parameter), or
- depending on the values from former years (time series).

At this stage data from other plots are only considered as far as the integrity of the database is concerned. The validity of a parameter is tested without taking other plots into account.

2.1.3 Uniformity Check

Data Uniformity is validated by testing the stability of a parameter as compared to data observed at neighbouring plots. Uniformity tests are more qualitative and constitute a first step into data evaluation. In contrast to compliance and conformity tests the method applied to check the uniformity tests is implemented as a semi-automated procedure. While tables and maps are produced automatically experts interpret the results and put the findings into a general context. The interpretation includes a comparison with external data as far as available.

2.2 Validation Messages

The results of the tests applied during validation are coded as a sliding scale of warning and error. The result of each validation test carries a message and associated severity code. The status

"error" is only given when the code exceeds, warnings are given to situations resulting in a code below 50. After the Conformity Check the NFCs are asked to check each flagged value and either confirm its correctness or (if the value was erroneous after all) resubmit a corrected survey.

2.2.1 Compliance Check Messages

At the Compliance Check stage, errors are fairly simple to detect and interpret. They are divided into three main types:

- Errors in the data submission procedure itself (missing mandatory form, not enough forms to complete the survey).
- Known "impossible" values within the files themselves, such as invalid dates, invalid characters and codes outside the given lists.
- Integrity checks within the survey to check that plots within the data file are also mentioned within the reduced plot file.

Warnings draw attention to missing optional forms (in case the NFC intended to submit the data but forgot), blank lines (in case this should have contained data) and comment lines (to confirm that the line should be there and is a genuine comment). At this stage no consideration is given to the plausibility of a given value, only whether it fits the stated data formats.

2.2.2 Conformity Check Messages

At the Conformity Check stage the actual data values are checked. As before, an error message confirms that something is wrong; however in this case it is not necessarily possible to ascertain precisely where the error lies. Most of these tests yield warning messages rather than errors as it becomes more difficult to detect values that are clearly erroneous.

Errors are divided into three main types according to the type of test applied:

- *Single parameter range tests* (e.g. values must be between 0 and 100 for percentage values).
- *Multiple parameter range tests* within a given survey (e.g. start date must be before end date).
- *Temporal consistency tests* (e.g. invariable parameters such as coordinates, altitude must not change).

Warnings are similarly divided. The single parameter range checks flag any data value that is outside an expected range for that parameter. Ranges were mostly derived from the legacy data set and identify any value outside an approximate 95% level. Multiple parameter range checks note anomalous combinations of values, and the temporal consistency tests check for unusual increases/decreases in parameters (e.g. diameter values should increase over time, but not by more than a certain amount).

The validation system therefore identifies impossible values and also many unusual ones. However, there are

limitations as to which conditions can be verified:

- The tests can detect an anomalous difference between two values but cannot compute which of them is erroneous.
- Submitted values that do not conform to the protocols may not be detected unless the value dimensions lead to data values outside the expected range.
- The range checks cannot pick up every implausible value, in particular in the meteorological data, because the ranges are set without geographic distinction.

The more complex the checks, the less clear-cut will be the results provided. The validation checks have to strike a balance between being too strict and thus incorrectly highlighting valid data or too broad to identify genuinely erroneous values.

2.3 Validation Results and Feedback from NFCs

The tests of the Compliance Check are performed on-line at the time of data submission. A report on the status of the data is generated instantly when testing the data before submitting the forms. Conformity and Uniformity checks are more complex and time-consuming and have to be performed off-line. NFCs receive by e-mail an automatically generated detailed report on the processing status containing any warnings and errors encountered. The communication to NFCs also contains a request for data correction(s) and/or confirmation(s).

The NFCs had the opportunity to react in different ways:

- extreme values are confirmed by the NFCs, corresponding registry lines will be flagged as extreme event;
- in case of errors, the NFC will have to correct the errors and resubmit the whole survey through the data submission module. The data then has to pass through the complete set of checks (compliance, uniformity and conformity) again.
- if no answer was delivered by the NFC before the deadline and/or errors are still identified, data were not loaded into the Forest Focus Monitoring Database.

3 LEVEL II 2003 MONITORING DATA

The review given in this *Executive Summary Report* relates to data from the 2003 monitoring period collected at the intensive monitoring plots of the scheme. The status of submitted data is given for surveys submitted until 10.03.2006 to coincide with the *Data Submission Report* for that year (European Commission, 2005). Results of the validation process include data received by 04.05.07 and any additional information provided by that date. Further details referring to the 2003 data submission status and analysis may be found in the related *Technical Report for 2003 Level II Data* (Hiederer, *et al*. 2007).

3.1 Schedule for Data Submission

According to the stipulation of the communication sent to countries participating in the scheme data for 2003 should have been submitted to the JRC by 31.12.2005. However, NFCs were put under a heavy strain by having to manage data from three monitoring periods under a new environment. As a consequence, the scheduled deadlines had to be extended several times during 2006 and finally in 2007 to allow for more surveys to enter the validation procedure.

The sequence of data submissions for the validation performed on the data from the data submission date is graphically presented in Figure 2.

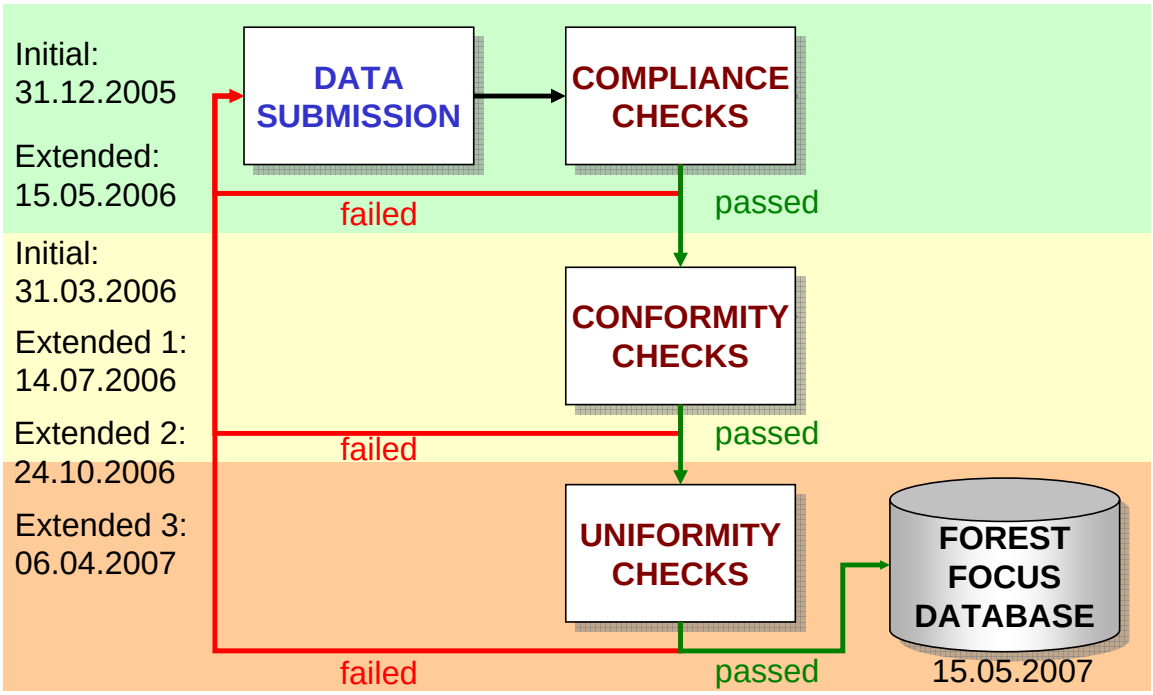

Figure 2: Data Validation Schedule for 2003 Data

Following the initial submission period of December 2005 re-submissions of corrected data and data for surveys not previously submitted could be uploaded by NFCs until 15.05.2006. Re-submissions of corrected data were scheduled with a deadline on 14.07.2006, which was extended to include also new submissions until 24.10.2006. Some NFCs asked for an extension of the submission period in October. To build the validation on the enlarged basis of validated 2002 data the DSM was opened again for re-submission of corrected surveys from 26.03. – 06.04.2007. Some data arrived later than that date and any survey or information received by 04.05.2007 was included in the validation process.

4 PROCESSING OF 2003 MONITORING DATA

Data collected during 2003 on Level II had to be received, managed and processed at the same time as data from 2002 and 2004. While the Compliance Check was performed at the time of data submission by NFCs independently of the year of the survey, tests related to Conformity and Uniformity include time-series analyses over several consecutive years of validated data. As a consequence, some tests of Conformity and Uniformity could not be performed following the absence of a time-series to analyse.

4.1 Data Submission and Compliance Checks

For the submission of 2003 monitoring data the NFCs had for the first time the opportunity to use the web-based Data Submission Module (DSM). The DSM allows the submitting authorities direct online checks of the data in form of a general and a detailed report. The reports are generated automatically for each survey submitted. They contain the information on the status of the survey and information for each warning or error found in the data with a comment on the nature of the problem.

4.1.1 Data Submission Status

An overview of the status of data submitted by NFC by 04.05.2007 is given in Figure 3. From all submission periods a total of 25 NFCs have submitted data for monitoring year 2003. Forms were submitted for 151 surveys. The number of surveys is lower than for 2004 and 2005 but has increased significantly comparing to previous 2002 monitoring year. The total number of surveys submitted for Forest Focus monitoring years as received by June 2007 is as follows:

- 2002 : 127
- 2003 : 151
- 2004 : 176
- 2005 : 191

One of the reasons for the increase is that the data were collected more widely for the recently defined surveys on Litterfall, Ozone Injury and Phenology.

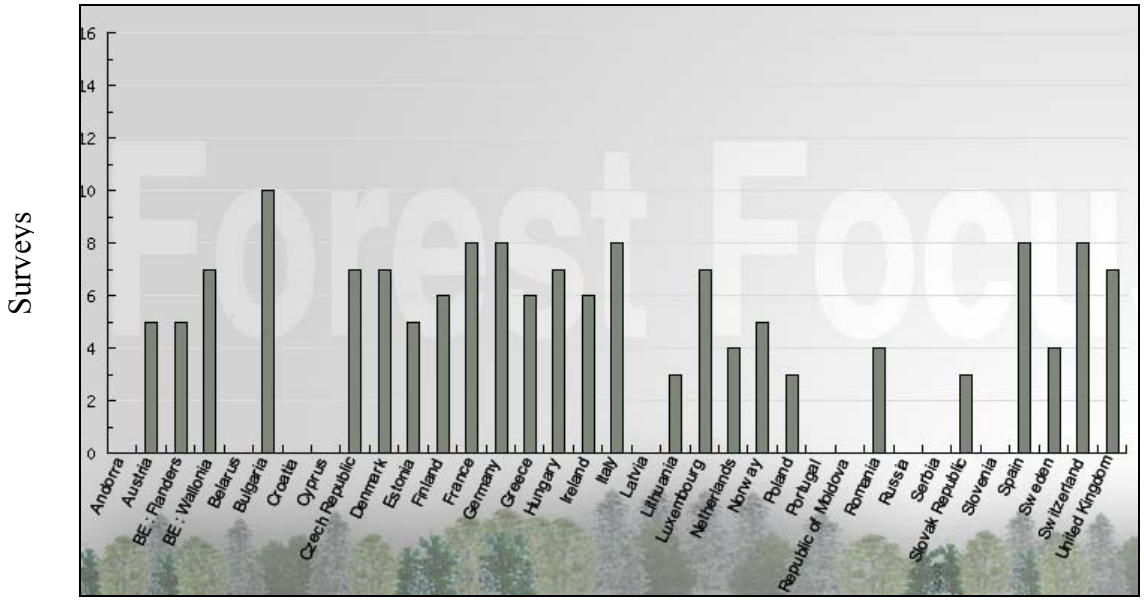

Figure 3: Number of Submitted Surveys by NFC (2003 Monitoring period, Status 04.05.2007)

4.1.2 Data Compliance Status

The status of data Compliance of all surveys submitted by NFCs at the end of the last submissions processed for 2003 (04.05.2007) is summarized in Table 1.

For the monitoring period of 2003 data were submitted for all surveys monitored although only one NFC submitted data for the Soil Condition survey. This circumstance can be explained by the long monitoring and sampling interval of 10 years for this survey. In total data were submitted for 151 surveys. Based on the number of NFCs most data were received for the surveys of Crown Condition (25), Deposition (25), Soil Solution (20), Foliage (18) and Meteorology (18).

Of all surveys submitted 59 (39%) were tested OK. Tested with warnings were 93 surveys (61%). None of the surveys generated error messages. Thus, all surveys could enter the next validation stage, which translates into 100% of surveys passing the compliance tests.

Table 1: Compliance Status for each Survey by NFC for the Year 2003

Country	Survey												
	SI	CC	SO	SS	FO	GR	DP	MM	GV	PH	AQ	OZ	LF
Austria	-	W	-	O	O	-	W	W	-	-	-	-	-
BE : Flanders	-	W	-	O	W	-	O	W	-	-	-	-	-
BE : Wallonia	O	O	-	O	O	-	W	O	O	-	-	-	-
Bulgaria	O	W	W	W	W	-	W	W	O	-	W	-	W
Cyprus	-	-	-	-	-	-	-	-	-	-	-	-	-
Czech Republic	O	O	-	O	O	-	O	W	O	-	-	-	-
Denmark	O	W	-	W	W	-	W	W	-	-	-	-	O
Estonia	O	W	-	W	O	-	W	-	-	-	-	-	-
Finland	-	W	-	W	W	-	W	W	W	-	-	-	-
France	-	W	-	O	-	W	W	W	-	W	-	W	W
Germany	O	O	-	O	O	W	O	O	O	-	-	-	-
Greece	O	W	-	W	O	-	W	W	-	-	-	-	-
Hungary	-	O	-	-	O	-	W	W	O	W	-	W	-
Ireland	W	W	-	W	W	-	W	W	-	-	-	-	-
Italy	O	O	-	O	O	-	W	O	O	-	W	-	-
Latvia	-	-	-	-	-	-	-	-	-	-	-	-	-
Lithuania	-	W	-	W	-	-	W	-	-	-	-	-	-
Luxembourg	-	W	-	-	W	-	W	W	-	O	W	-	W
Netherlands	-	O	-	W	O	-	W	-	-	-	-	-	-
Norway	-	W	-	W	W	-	W	-	O	-	-	-	-
Poland	-	W	-	-	-	-	O	-	O	-	-	-	-
Portugal	-	-	-	-	-	-	-	-	-	-	-	-	-
Romania	O	W	-	-	-	-	W	-	-	W	-	-	-
Slovak Republic	-	W	-	-	-	W	W	-	-	-	-	-	-
Slovenia	-	-	-	-	-	-	-	-	-	-	-	-	-
Spain	-	O	-	O	-	W	O	O	-	O	O	W	-
Sweden	-	O	-	W	-	-	W	W	-	-	-	-	-
Switzerland	-	W	-	W	W	-	W	W	W	-	W	W	-
United Kingdom	O	W	-	O	O	-	W	W	-	-	O	-	-
TOTAL	**11**	**25**	**1**	**20**	**18**	**4**	**25**	**18**	**10**	**5**	**6**	**4**	**4**
Relative OK	**91%**	**32%**	**0%**	**45%**	**56%**	**0%**	**20%**	**22%**	**80%**	**40%**	**33%**	**0%**	**25%**
Relative OK, OK with Warning	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Status: 04.05.2007

O	= OK	W	= OK with warnings	E	= Errors detected

4.2 Conformity Check

At the end of the Conformity Check NFCs were informed with respect to any problems encountered when subjecting the data to the tests. Each NFC received an automatically generated detailed processing status report, in which the problems met were presented. A request for correction(s) and/or confirmation(s) was included in the report. Corrected and re-submitted data were re-processed and the new status determined.

4.2.1 Data Conformity Status

The status of the surveys after the Conformity Check is summarized in Table 2. The table presents for each survey, for each country participating and for the three years (2001/2002/2003) the conformity status for the compliant submitted surveys.

Some of the tests for Conformity include data from the legacy database. The legacy data of the FFMDb originate from a delivery made by FIMCI to DG AGRI in August, 2003 and covers monitoring years up to 2001. For all legacy data it is assumed that the surveys are fully validated according to the procedures applied at the time. Legacy data for 2001 were evaluated according to the tests of data Conformity and Uniformity to assess their influence on data from subsequent monitoring periods (Hiederer *et al.*, 2007).

Similarly to the previous 2002 monitoring year, no Conformity Checks were performed due to missing data for the following NFCs which have submitted data in former years from Level II plots: Croatia, Latvia and Portugal.

A summary by the level of Conformity of the data is as follows:

- System instalment, Soil Condition, Air Quality, Ozone, Litterfall: 100.0 %
- Phenology: 80.0 %
- Soil Solution: 73.7 %
- Crown Condition: 70.8 %
- Foliar: 70.6 %
- Ground Vegetation: 70.0 %
- Deposition: 66.7 %
- Meteorology: 58.8 %
- Growth: 50.0 %

Table 2: Data Conformity Status of 2003 by Country and Survey

Year 200-	SI			CC			SO			SS			FO			GR			DP			MM			GV			PH			AQ			OZ			LF			TOTAL 2003
	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	1	2	3	
AT				✓	✓	✓				✓	×	×	✓	×	×				✓	×	×	✓	✓	×	✓															5
BE		×	✓	✓	✓	✓				✓	×	✓	✓		×				✓	✓	✓	✓	✓	✓		✓	✓													7
BG			✓			✓			✓			✓			✓						×			×			×					✓						✓		10
CH		✓		✓	✓	✓				✓	✓	✓	✓		✓				✓	✓	✓	✓	✓	✓			✓					✓	✓		✓	✓				8
CY																																								
CZ			✓	✓	✓	×				✓	×	×	✓		×				✓	✓	×	✓	×	×			✓													7
DE		×	✓	✓	×	×				✓	×	×	✓	×	×	✓	×	×	✓	×	×	✓	×	×	✓	×	×													8
DK		✓	✓	✓	✓	✓				✓	✓	✓	✓		✓				✓	✓	×	✓	✓	×		✓					✓						✓	✓		7
EE			✓	✓	✓	✓				✓	✓	✓	✓		✓				✓	✓	✓				✓															5
ES				✓	✓	✓				✓	×	✓	✓	✓			×	✓	✓	✓	✓	✓	✓	✓					×	✓	✓	✓	✓		✓	✓				8
FI				✓	×	✓				✓	×	✓	✓		✓				✓	×	✓	✓	✓	✓	✓	✓	✓													6
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SI																																								
SK				✓	×	✓							✓			✓	×	×	✓		✓																				3
UK		×	✓	✓	×	×				✓	✓	✓	✓	✓	×				✓	✓	✓	✓	✓	✓	✓							✓	✓							7
Conform		5	11		15	17		0	1		8	14		5	12		1	2		15	16		11	10		4	7		3	4		6	6		3	4		3	4	108
Total	0	5	11	24	23	24	0	0	1	16	17	19	22	8	17	4	4	4	22	22	24	14	16	17	8	5	10	0	4	5	4	6	6	0	3	4	0	3	4	146
Relative (%)		100.0	100.0		65.2	70.8			100.0		47.1	73.7		62.5	70.6		25.0	50.0		68.2	66.7		68.8	58.8		80.0	70.0		75.0	80.0		100.0	100.0		100.0	100.0		100.0	100.0	74.0

✓ Legacy Data ✓ Data conform × Data not conform

2003 status based on validated previous survey(s) 2003 status based on validated 2001 survey with 2002 survey not conform

✓ The previously confirmed data were later found to be incorrect and corrected data were re-submitted by the NFC.

4.2.2 Summary of Conformity Check

The tests of the Conformity Check were performed for the survey that passed the Compliance Check. In total 2590 tests were performed on the surveys. The surveys passed 80% of the tests (75% for the previous 2002 monitoring year). The results of tests with warnings or errors were communicated to the NFCs concerned for verification of the situation or correction of any erroneous data. The various tables describing the analysis made by country may be consulted in the *Technical Report 2003 Level II Data* (Hiederer, *et al*, 2007).

The test routines used for the Conformity Check detect unlikely values for a defined data range (outside approximately 95% of cases). The range limits were mostly derived from the Level II legacy data validated by the Forest Intensive Monitoring Coordinating Institute (FIMCI) and from expert knowledge. Therefore, a value outside the ranges does not necessarily signify that a value is erroneous and should be rejected. The NFCs are asked to pay attention to those values and state if the values are accurate and should be treated outliers, or if the data need corrections and have to be re-submitted.

The range tests triggered many warnings, especially for measurements in the forms of the Meteorological survey (proportion of messages triggered were even higher than for the previous 2002 monitoring year). The reasons are the large amount of data and therefore a higher probability of identifying outliers. Another factor contributing to the number of messages for the meteorological data is that the ranges are set to be the same for all countries. This makes it easier to reconstruct testing conditions, yet it means that countries with an intermediate climate tended to receive fewer warnings with the potential in these cases that some outliers may be overlooked.

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, such as tree species;
- continuity of the change of variable values, such as age of tree;
- the treatment of missing values and values below the detection/quantification limits.

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 the first time, the location of a plot had changed, or the previous submitted value was incorrect or measured with less accuracy, in particular plot co-ordinates.

Warnings concerning continuity of changes with an abnormal progression were only found in data of the Growth Assessment survey; for instance the occurrence of apparently “shrinking” trees, meaning the diameter or the height is smaller than in the previous measurement. In many cases the data were corrected by the NFCs and re-

submitted. However, some situations were also confirmed by NFCs following an unusual time interval between two measurements, incorrect measuring technique applied during previous assessments, or stem breaks.

A particular problem was encountered associate with values of "-1" and zero. A high number of warnings mainly in the data of the Soil Solution and Deposition surveys were due to the use those values. The "-1" values were in most cases confirmed by the NFCs as a code for measurements below the detection limit of instrument used. The disparate use of zero entries was found to pose a significant problem to the meaning of the measurement. The value was used to code the absence of a measurement, code values below the field format limit (rounded to "0") and measurement outside the detection / quantification limit. As a consequence, specific recommendations with respect to the use of "-1" and zero in the data were set down by the JRC and communicated to the NFCs.

4.3 Uniformity Check

The tests applied for the Uniformity Check provide an interpretation of temporal and spatial development of parameters. Only surveys passing the conformity checks are subjected to tests for uniformity. The tests include an automatic procedure for generating tables, graphs and maps. Results are manually interpreted by experts. The findings are presented for selected parameters of the Crown Condition, Soil Solution and Deposition surveys.

4.3.1 Crown Condition

The Uniformity of Crown Condition data is evaluated by mapping the mean plot defoliation 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 resulting graphs of the first three species are presented in this section. 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 presented according to 6 classes (0-10%, 11-20%, 21-30%, 31-40%, 41-50%, 51-100%).

Mean plot defoliation of *Pinus sylvestris* is shown in Figure 4. The density of validated mean defoliation data is highest in southern Sweden. The majority of the Swedish plots show a mean defoliation between 0 and 20%, but there are also several plots showing defoliation of up to 30% and two with up to 40%. The high density of Level II plots and their relatively small spatial variation of defoliation in southern Sweden suggest a comparison with defoliation assessed on Level I plots in that region. Most of the Level I plots show also a mean defoliation between 0 and 20%, with several plots reaching up to 30% and even to 40 % defoliation (Lorenz, *et al*., 2004). Furthermore, for a few Level I plots in southern Sweden defoliation exceeds the values found at Level II plots, ranging from 51% to 100%. Defoliation on plots in Norway, Estonia and Austria is mainly below 20%. The ancillary data does not provide evidence to reject the Level II on the grounds of spatial inconsistency. Higher levels of defoliation were reported for plots in the Slovak

Republic, Switzerland and Portugal ranging from 21% to 40%. For two plots located in Norway defoliation ranging from 51% to 100% was detected.

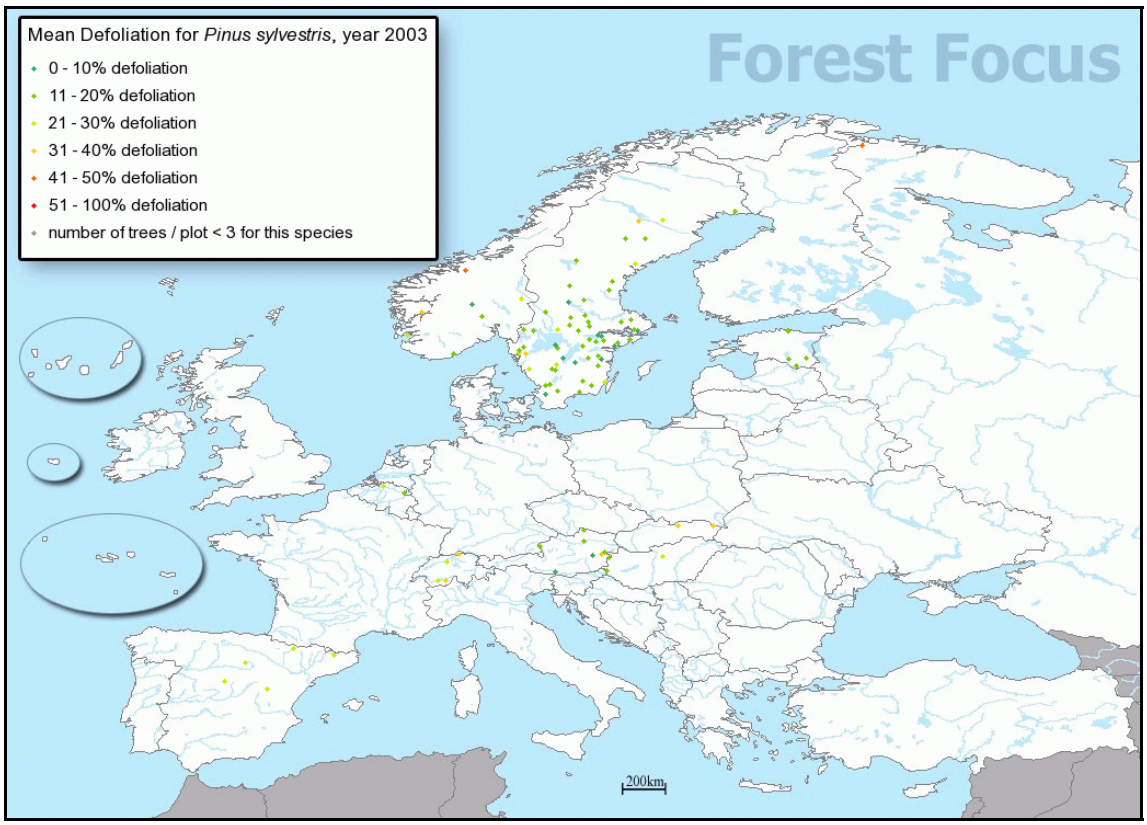

Figure 4: Mean Defoliation of Pinus sylvestris

The results of mapping mean plot defoliation of *Picea abies* are shown in Figure 5. Also for this species the highest density of validated plots is found in southern Sweden, Austria and Switzerland. On most plots in southern Sweden, Austria, Belgium, Denmark and northern Italy defoliation is below 10%, but there are also several plots showing defoliation of up to 20% (except in Belgium and Denmark). The trees observed in Switzerland and in the Slovak Republic show higher levels of defoliation ranging from 21 to 30%. There is also one plot with up to 40% defoliation (in Switzerland) and two plots ranging from 51 to 100% defoliation (in Switzerland and in the Slovak Republic). Comparatively high levels of mean defoliation ranging from 41 to 100% were also reported for Norway.

In areas with high density of Level II plots these results are comparable to those described for the Level I plots for the year 2003 (Lorenz *et al*., 2004). One obvious exception is the high mean defoliation in Norway. The higher level of defoliation found on the Level II plots is due to the involvement of trees belonging to the social class 4 (suppressed) which are not part of the sample on Level I plots. A high

proportion of those trees have had a very high degree of defoliation. Consequently, the selective nature of the Level II plots could explain the discrepancy and the data, although not homogenous, could be accepted as still uniform within the limits of the information available.

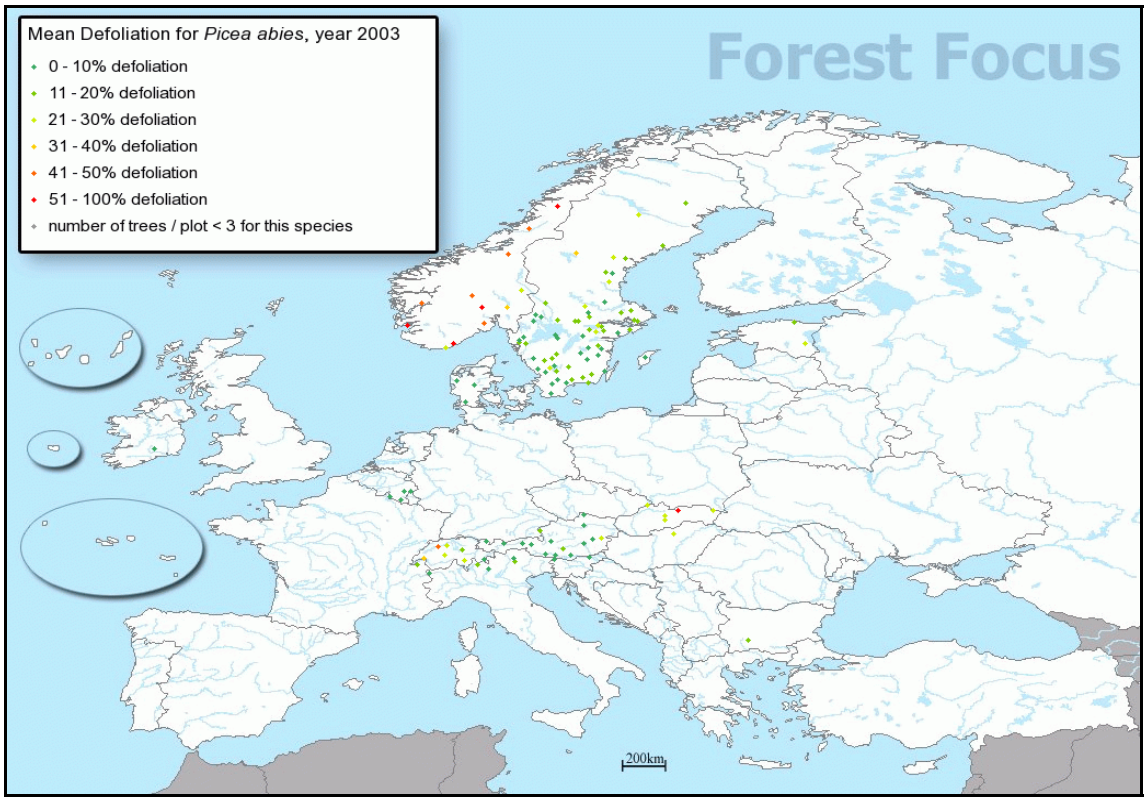

Figure 5: Mean Defoliation for Picea abies

Mean plot defoliation of *Fagus sylvativca* in 2003 is shown in Figure 6. Mean plot defoliation is lowest in Austria, Belgium, Italy and Switzerland with up to 10% on most of the plots. There are, however, several plots with up to 20%, especially in Switzerland. Plots of higher defoliation can be found in Slovak Republic, Portugal and southern Sweden where mean defoliation ranges between 11 and 40%. In three exceptional cases in southern Sweden, Hungary and Luxembourg defoliation reaches up to 50%. As far as a comparison is suggested because of high plot density, the defoliation found on Level II plots is confirmed by the results of the survey at Level I.

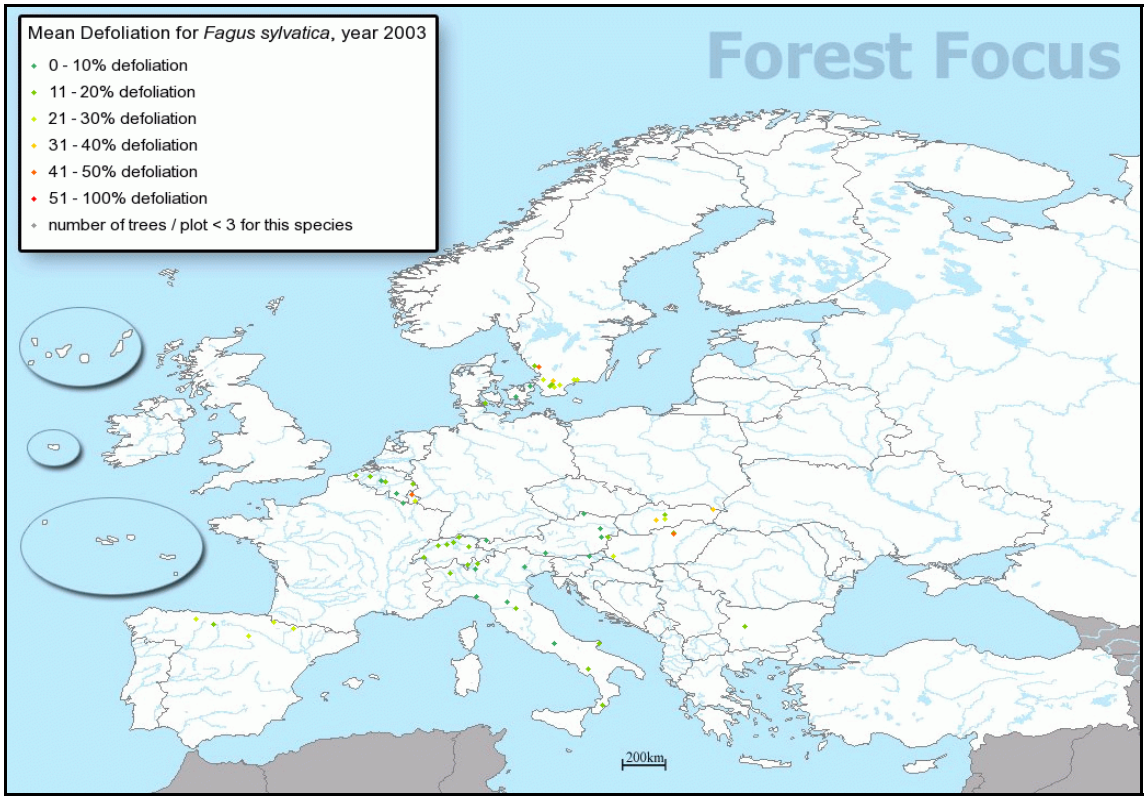

Figure 6: Mean Defoliation of Fagus sylvatica

4.3.2 Soil Solution

For tracing changes in soil solutions the concentrations of sulphur ($S\text{-}SO_4$), nitrate nitrogen ($N\text{-}NO_3$) and ammonium nitrogen ($N\text{-}NH_4$) are the key parameters observed in the soil solution survey. 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 presented 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 2003 observed for the compound $S\text{-}SO_4$ is presented in Figure 7. For plots located in Norway, Finland, Estonia, Austria and France the $S\text{-}SO_4$ concentration ranges between 51% and 125% of the average concentration measured for the previous five years. The highest variability for $S\text{-}SO_4$ concentrations ranging between below 50% and 150%was reported for plots in United Kingdom. Furthermore for one plot in Finland the reported concentration is above 150% of the average concentration measured for the previous five years. For several plots

located in Finland, Italy and Portugal no values were available for any of the previous five years.

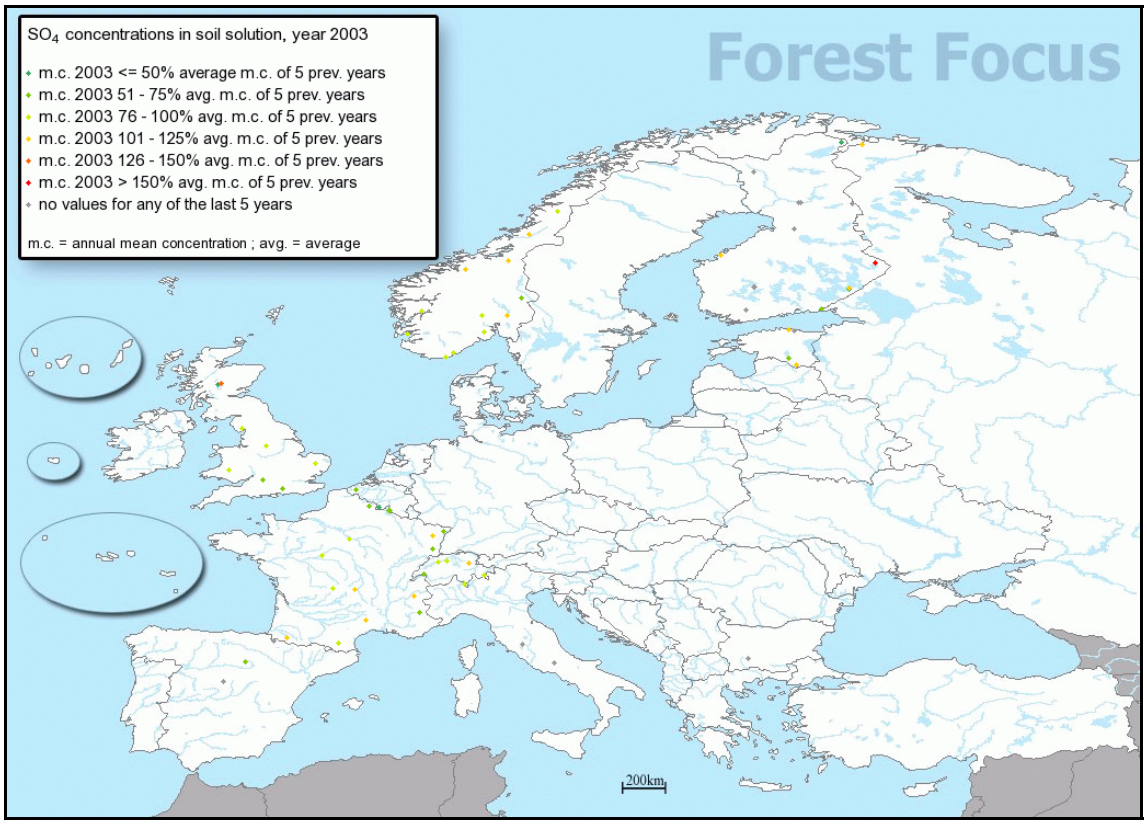

Figure 7: SO_4 Concentrations in Soil Solution

The mapped concentrations of $N\text{-}NO_3$ are presented in Figure 8. The majority of nitrate concentrations observed in Norway and on several plots located in United Kingdom, France and Italy are below 50% of the average concentration measured for the previous five years. For plots in Estonia, Switzerland and France $N\text{-}NO_3$ concentrations between 101% and 125% were reported. Several plots with nitrate nitrogen concentrations above 150% were found for plots in the United Kingdom and France. In Switzerland, Finland and Norway one plot with concentrations above 150% was found each. For almost all plots in Finland no values for any of the last five years were available.

The data monitored for the parameter $N\text{-}NH_4$ of the soil solution survey is shown in Figure 9. Data are mapped for plots in Finland, United Kingdom, France, Belgium and one plot in Switzerland and Italy respectively. A high variability of $N\text{-}NH_4$ concentrations was detected for plots in United Kingdom ranging between below 50% and above 150% of the average concentration measured for the previous 5 years. For several plots located in France and one plot in Belgium concentrations above 150% were reported.

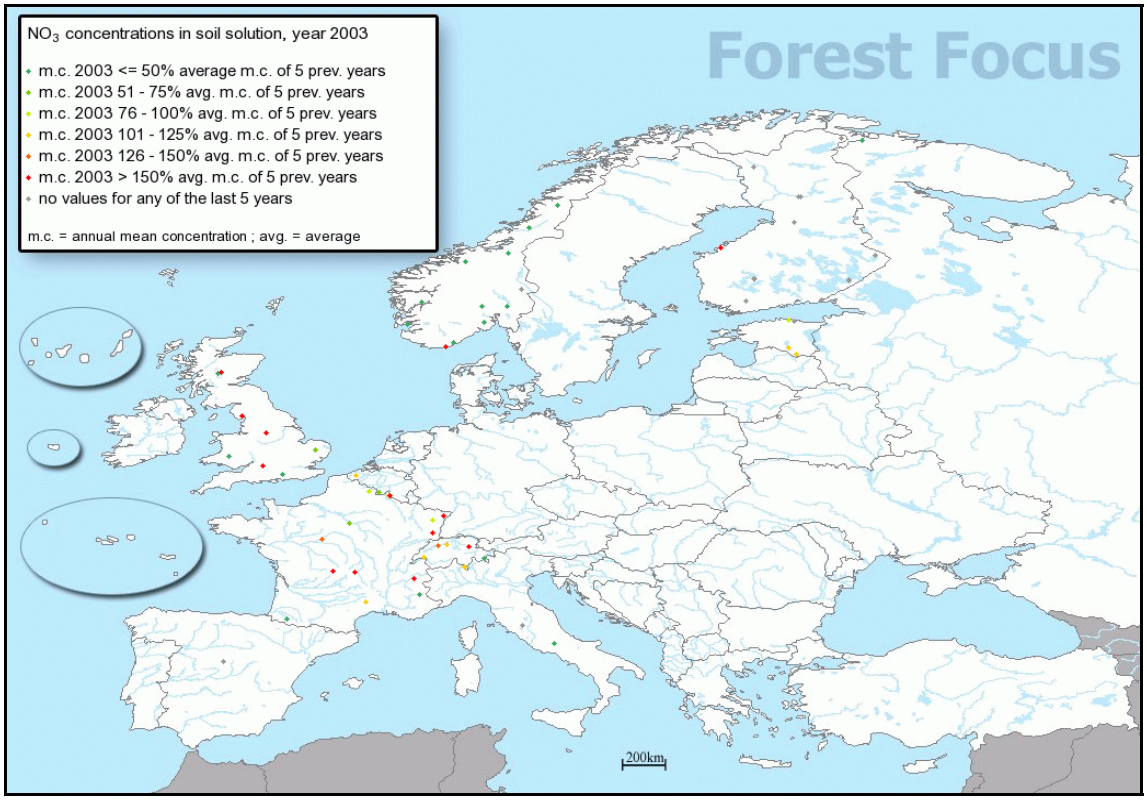

Figure 8: NO_3 Concentrations in the Soil Solution

Figure 9: NH_4 Concentrations in the Soil Solution

4.3.3 Deposition

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 particular reporting year. 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 second series of maps takes precipitation of the respective year into account as a major additional influence on the concentrations. The purpose of those maps is to reveal sudden changes in concentrations of the depositions related to the amount of water (quantity of precipitation) in the bulk deposition.

The quantity weighted mean concentrations of S-SO_4 in bulk deposition are given in the Figure 10.

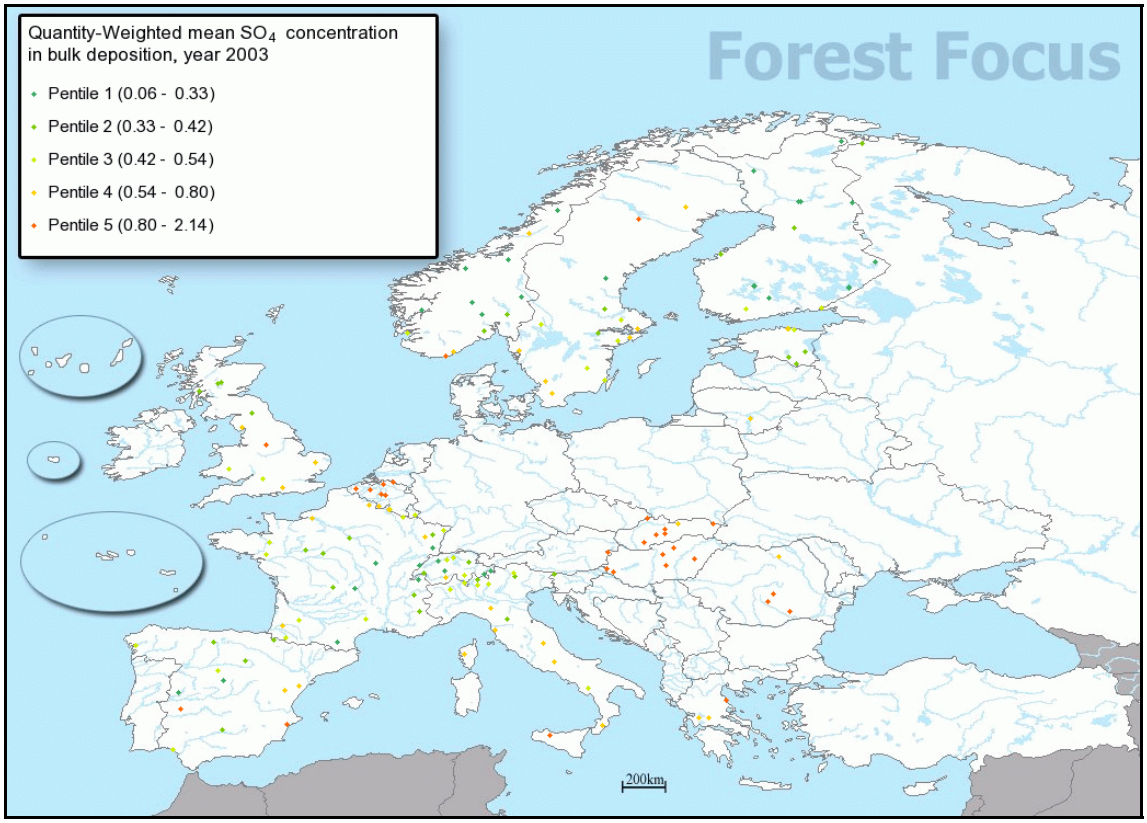

Figure 10: Quantity-weighted Mean SO_4 Concentration in Bulk Deposition

Plots of highest S-SO_4 concentrations can be found in Belgium, Slovak Republic, Hungary and Romania ranging from 0.8 to 2.14 mg/l. For plots located in Norway, Finland, Estonia, France, Switzerland and Spain lowest sulphate concentrations ranging from 0.06 to 0.42 mg/l were reported. The depositions measured in Sweden, the United Kingdom, Italy and Greece are an order of magnitude below those reported for areas of high input such as the Belgian ones but higher than most of the plots located in Norway and Austria.

The quantity-weighted nitrogen concentrations in bulk deposition are shown in the Figure 11 and Figure 12.

The spatial pattern of these data is similar to those of the sulphur concentrations. The highest N-NO_3 concentrations ranging from 0.53 to 3.04 mg/l were observed on almost all plots in Belgium and on several plots in Sweden, Italy, Slovak Republic and Hungary. The same spatial distribution applies or N-NH_4 concentrations (Figure 22). The highest N-NH_4 concentrations are between 0.86 and 2.48 mg/l (Figure 24). Plots with lowest concentrations of the two nitrogen compounds are most frequent in Norway, Finland, the United Kingdom, France and Spain. Low nitrate concentration can also be found in Estonia.

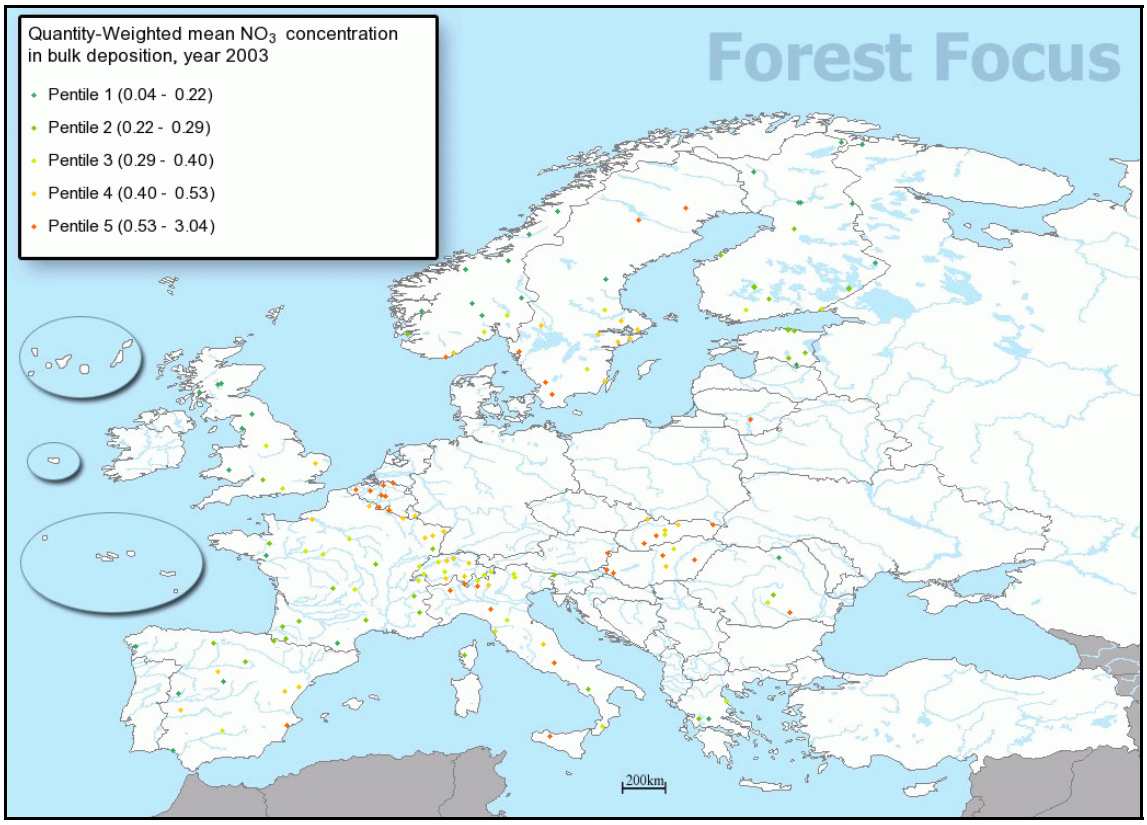

Figure 11: Quantity-Weighted Mean NO_3 Concentration in Bulk Deposition

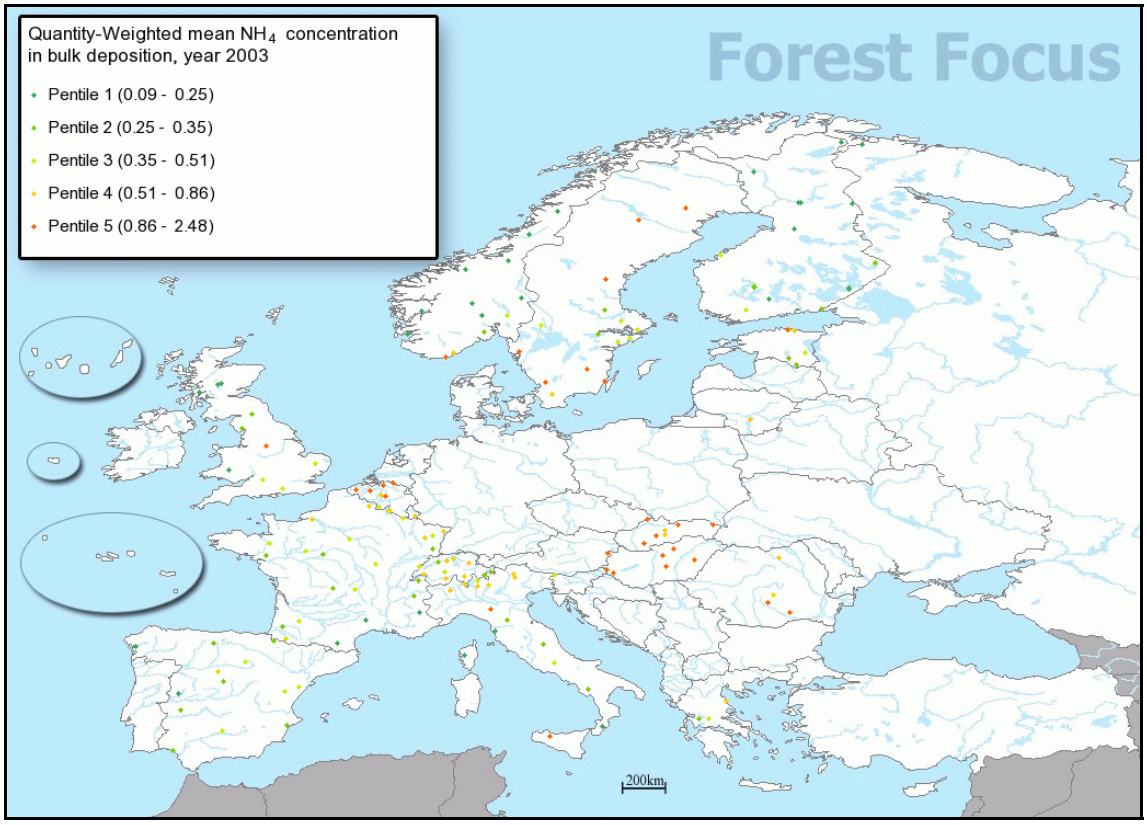

Figure 12: Quantity-Weighted Mean NH_4 Concentration in Bulk Deposition

The data for deviations in the quantity-weighted mean depositions of the monitoring year 2003 from the average deposition reported over the previous 5 years are mapped for the three selected parameters in Figure 13 ($S\text{-}SO_4$), Figure 14 ($N\text{-}NO_3$) and Figure 15 ($N\text{-}NH_4$). For a small number of scattered plots the element concentrations in bulk deposition for the three parameters are below 50% of the average values of the previous 5 years such as in Estonia and Spain. For the majority of plots the values range between 76% and 125%. A small number of plots show an increase in concentrations above 150% in comparison to the previous five years such as in Sweden, Norway and Switzerland. Increasing $N\text{-}NH_4$ concentrations are obvious for several plots located in Sweden, Norway and Switzerland. The respective 2003 values were not found to be outside the range of observations.

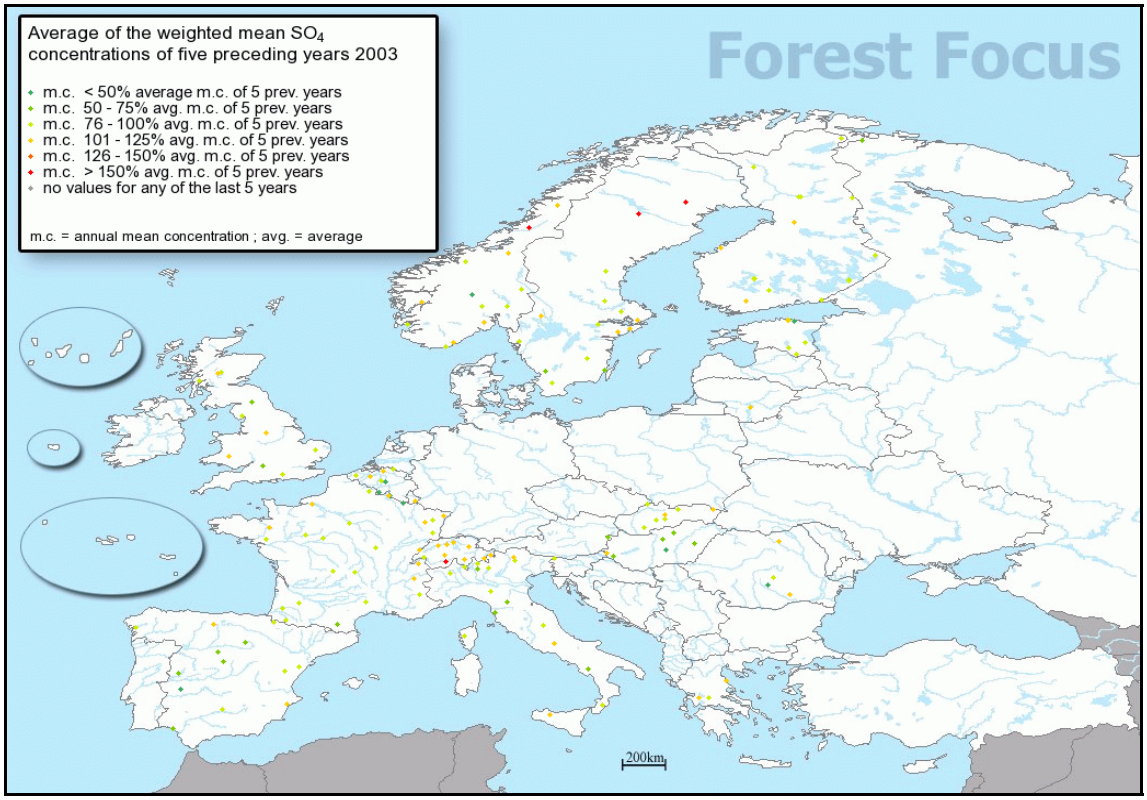

Figure 13: Average of the Weighted Mean SO_4 Concentration of 5 preceding Years

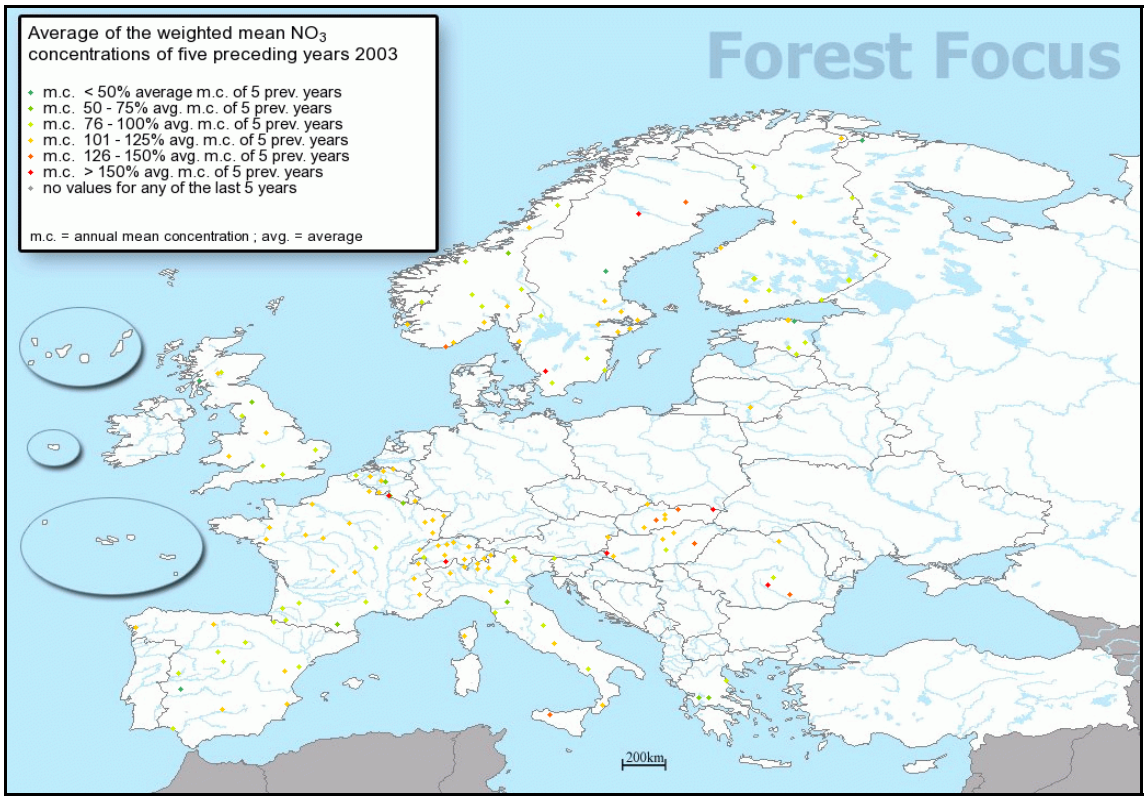

Figure 14: Average of the Weighted Mean NO_3 Concentration of 5 preceding Years

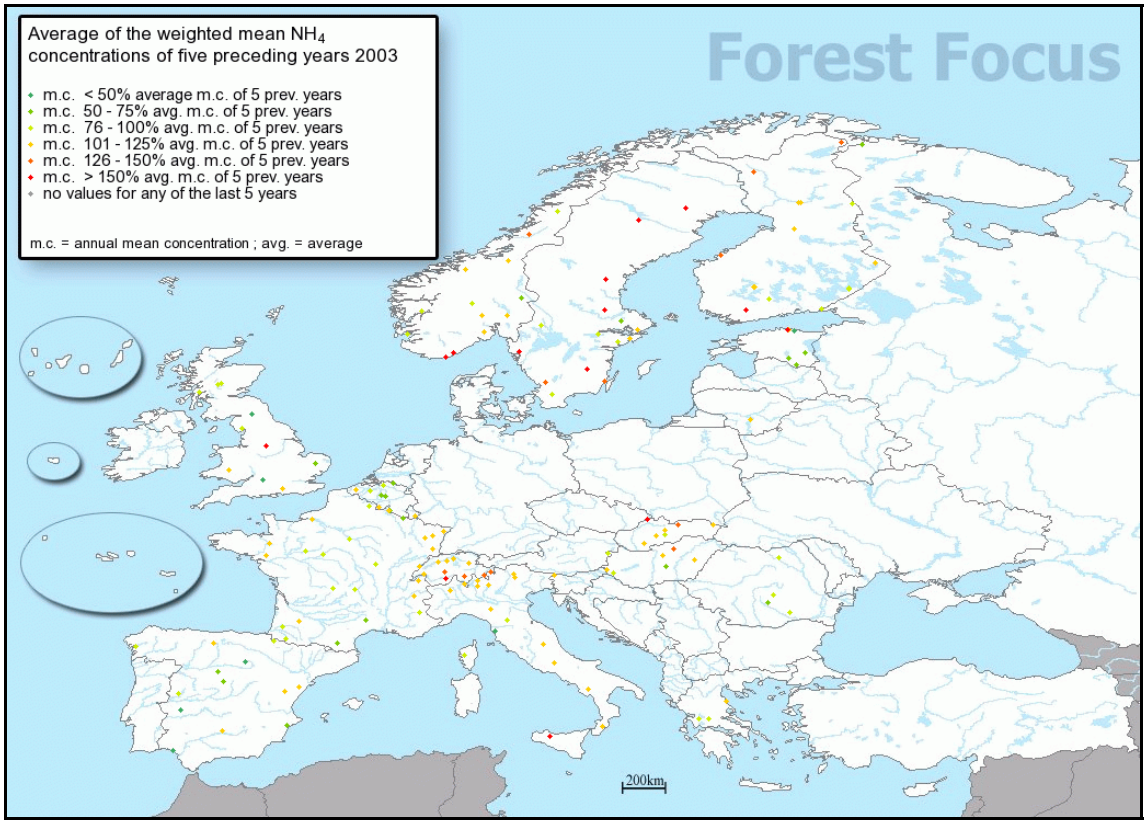

Figure 15: Average of the Weighted Mean NH_4 Concentration of 5 preceding Years

4.4 Data Stored in Forest Focus Monitoring Database

A summary of all surveys successfully validated for 2003 monitoring year and transferred to the FFMDb is given for each survey per country in Table 3. The 108 surveys from 24 countries could be uploaded into the Forest Focus Monitoring Database (for 2002 monitoring year: 79 surveys from 21 countries were uploaded in the FFMDb). In 40 cases the surveys were uploaded despite the identification of warnings or errors during the Conformity Check after clarification from the respecting NFC. As result of the combination of validation by Conformity and Uniformity Check and the NFC requests for checking the conformity results, all submitted surveys could be transferred to the FFMDb for the following countries: Estonia, France, Greece, Italy, Luxembourg, Norway and Sweden. No survey could be uploaded into the FFMDb for Poland.

Most of the surveys loaded were for Crown Condition (17), Deposition (16) and Soil Solution (14) and Meteorology (10). Soil condition analysis should be submitted only every ten years, so in only one case data were submitted for the monitoring year 2003 and stated conform and uniform and accordingly pushed into the FFMDb.

Table 3: Surveys uploaded to the FFMDb after Validation Checks

Country	Survey													Rel.
	SI	CC	SO	SS	FO	GR	DP	MM	GV	PH	AQ	OZ	LF	%
Austria		✓												20.0
Belgium	✓	✓		✓			✓	✓	✓					91.7
Bulgaria	✓	✓	✓	✓	✓						✓		✓	70.0
Cyprus														
Czech Republic	✓								✓					28.6
Denmark	✓	✓		✓	✓								✓	71.4
Estonia	✓	✓		✓	✓		✓							100
Finland		✓		✓	✓		✓	✓	✓					100
France		✓		✓		✓	✓	✓		✓		✓	✓	100
Germany	✓													12.5
Greece	✓	✓		✓	✓		✓	✓						100
Hungary		✓			✓		✓		✓			✓		71.4
Ireland	✓	✓			✓									50.0
Italy	✓	✓		✓	✓		✓	✓	✓		✓			100
Latvia														
Lithuania				✓			✓							66.7
Luxembourg		✓			✓		✓	✓		✓	✓		✓	100
Netherlands					✓									25.0
Norway		✓		✓	✓		✓		✓					100
Poland														0.0
Portugal														
Romania	✓						✓			✓				50.0
Slovenia														
Slovak Republic		✓					✓							66.7
Spain		✓		✓		✓	✓	✓		✓	✓	✓		100
Sweden		✓		✓			✓	✓						100
Switzerland		✓		✓	✓		✓	✓	✓		✓	✓		100
United Kingdom	✓			✓			✓	✓			✓			71.4
Total	11	17	1	14	12	2	16	10	7	4	6	4	4	74.0

Conformity and Uniformity Checks include the analysis of time series for several parameters. A consequence of establishing time-series for the current validation process is that surveys with an annual observation interval, such as Crown Condition, must be available in a compliant and conform status at least for the years 2001, 2002 and 2003. This requirement has limited the amount of data available for validating data for uniformity. But at least for Crown Condition the time series are mostly complete. Data from 2001 legacy data had to be used for validating 2003 data whenever no valid 2002 data exist.

4.5 Specific Problem: Treatment of Values Zero and -1 in Fields for Measured Parameters

After the data submission of the monitoring year 2003 the situation of the use of zero and/or "-1" is still heterogeneous. 25 different NFC have submitted data from the soil solution and or from the deposition survey. For Soil Solution data 7 NFCs used a zero and 11 NFCs used "-1". In the data forms of the Deposition survey 10 NFCs used a zero and 11 NFC used "-1". In most cases the NFC chose either to use zero values or "-1". Nevertheless six NFCs (Denmark, Germany, The Netherlands, Poland and Switzerland) used both values in one survey. Switzerland in particular indicates rounded values with zero where the value is still too high for a column even if using the floating format. In comparison to 2002 some NFCs like France Italy followed the recommendation and renounced to use the zero. Instead "-1" was used to define values below the detection/quantification limit.

The reactions of the requests after the conformity checks where zero values and "-1" values triggered warning messages, which were asked to explain, were not complete. The highest ratio of explanations was given for the use of -1 values of the Deposition and Soil Solution data. As expected Seven NFCs stated as expected that "-1' were used as a code for 'below detection / quantification limit'. Values of "-1" values were not used with any other meaning. For all remaining cases without an explanation, it is very likely that -1 is also used in the same way, because it is a valid code according to ICP Forests manual.

The representation of missing data should be addressed by the Expert Panels and specific guidelines should be adopted and included in the ICP Manual. In the absence of such guidelines the JRC has developed specific rules for treating zero values in data submitted by NFCs for monitoring periods from 2002 onwards (Hiederer, *et al*., 2007).

The general approach to treating "missing data" in the validation process of the Forest Focus Monitoring Database has to take the properties of the legacy data into account as well as the variety of treatment of "missing data" by NFCs. The validation process is therefore based on the identification of valid values for measured or observed parameters. In this the approach differs profoundly from the identification of codes signifying missing data.

The recommendations presented are given below, separated by the situations to which they apply:

a. Measured, but outside field specifications

- **Value too small for format specified for field**

  A measurement of a value should be recorded as measured, shifting the decimal point as needed. Data should not be rounded except where shifting the decimal point is still

insufficient to record the measured value. For example, the format for recording N-NO_3 in the Soil Solution survey specified as 999.9. A measured value of 0.03 should be recorded as such. In the example given rounding should only be applied for values <0.001.

- **Value too large for field format**

  A measurement of a value should be recorded as measured without the decimal part. For example, alkalinity in the soil solution at times exceeded 999.9µmolc/l. A value of 1500 should be recorded as such in the field. Data should not be entered into the field "Other observations".

b. Measured, but below limits of detection for instrument

The use of -1 for a measurement is defined to code a value below the detection limits of the instrument used. This condition occurs frequently in soil solution data. The values should not be rounded, interpolated or marked by a zero entry.

c. No Measurement

The field should be left empty. The condition should **not** be coded by using a zero entry, although this is sometimes recommended.

Cases a. and b. have been largely eliminated. The decimal point in the format is no longer tied to a fixed position. A format specified as 999.9 can hold values from 0.001 to 99999. It would have been preferable to adjust the field dimension in the format specifications. However, the process of modifying the specifications is lengthy and would not solve actual problems.

All data not considered valid measurements are highlighted in the reports as either warnings or errors. The NFCs are given the opportunity to consider the values reported and can confirm the values or re-submit modified data.

5 SUMMARY

Data collected by the surveys of 2003 were submitted by NFCs together with the 2002 and 2004 data at the end of December 2005. Data submission and the subsequent validation by the JRC were carried out according to the stipulations of Forest Focus. With respect to the measurement methods in the field and the format specifications for the submission for the survey data some of the surveys differed between years. Together with the new submission procedure under Forest Focus this has caused a substantial management overhead for the NFCs and the JRC.

The validation process starts with the Compliance Check which is performed before data are submitted by NFCs and which is an integral part of the web-based data submission module. The tests help NFCs to identify problems in the data format with an immediate response of the system before the surveys are submitted. The module further allows retrieving information of previously submitted files for all years. The main problem encountered during data submission was that the specified data formats were not always sufficiently adapted to recording the observations. When using a strict interpretation of the field specifications for reporting values in the forms, extreme values, both small and large, could not be stored properly. The problem could be solved by using a more supple interpretation of the field format by not fixing the position of the decimal point. This solved all problems of recording valid measurements.

The Conformity Check verifies the temporal consistency of values reported for static parameters, like plot coordinates, and values of the measured data with respect to pre-defined ranges of for minimum and maximum values. One particular problem encountered was the coding of missing data and measurements outside the detection limit of the instrument or the field dimensions. Since no proper and defined guidelines were commonly applied to consistently report such data a set of instructions were developed and communicated to NFCs on how to deal with those cases. The Uniformity Check uses an expert interpretation of mapped parameters for the monitoring year and temporal changes between years to assess the special and temporal stability of the measured parameters between plots and NFCs.

The submission of 2003 data was expected to be completed with the last period of opening the DSM from 26.03. to 06.04.2007, although later re-submissions occurred. For the monitoring year of 2003 a total of 151 surveys were submitted by 25 NFCs. The intensity of data submissions for the 13 surveys ranges from 1 for Soil Condition to 25 for Crown Condition and Deposition. Of all surveys submitted 59 (39%) were tested OK. Tested with warnings were 93 surveys (61%). None of the surveys generated error messages and, consequently, all submitted surveys could enter the next validation stage of the data Conformity Check.

The Conformity Check showed that in 20% of the 2590 performed tests situations generating warnings or errors were found by the routines. During subsequent communications with the NFCs the data quality could be significantly improved. NFCs

corrected erroneous data and re-submitted the surveys concerned or could verify the validity of data found outside the limits of range tests. At the end of the validation phase for 2003 monitoring year, out of 151 submitted surveys from 25 NFCs (24 countries), 108 surveys could be fully validated and uploaded into the FFMDb.

The main reason for the failure of the surveys to pass the validation process stems from the errors generated when testing values for temporal consistency. The messages were mainly generated by inconsistencies found for static parameters, such as changes in site coordinates or tree species. Other situations generating warnings caused by values outside the expected ranges or anomalies from the general trend, e.g. shrinking trees, could usually be declared extreme events. More surveys could have been transferred to the FFMDb had all NFCs reacted to the reports sent on the Conformity status of the surveys.

Recommendations for improving the rate of data passing the validation checks are summarized as follows:

- The existing data format specifications as published by the JRC for a given monitoring year should be followed closely.
- Missing data and measurements below the detection limit of the instrument used should be coded according to the guidelines provided. Never use zero to indicate a missing measurement for non-categorical parameters.
- The data formats in use should be revised by the Expert Panels in charge of the various parts of the ICP Forests Manual with respect to the dimensions of the fields used.
- Any changes to the monitoring setup or instruments used should be documented as DARs.
- NFCs should verify their data after having received the Conformity Status reports and react in case any messages are generated.

The results obtained from the validation activity and presented in this report are encouraging with respect the extension of the number of surveys performed on Level II plots and the improvements made in the quality of the data submitted over 2002. Yet, the experience of the Level II data management also demonstrated the need for a data quality procedure to be applied and that the process should be automated to provide more consistent results.

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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).

According to Article 15(1) of the Forest Focus Regulation Member States shall annually, through the designated authorities and agencies, forward to the Commission geo-referenced data gathered under the scheme, together with a report on them by means of computer telecommunications and/or electronic technology. For managing the data JRC has implemented a Forest Focus Monitoring Database System.

This Executive Report presents the results obtained from all processing stages (data reception, validation checks – compliance, conformity, uniformity) for submitted data referring to the monitoring year 2003. This report presents the results at the end of the processing phase after data have been re-submitted in 2007. It presents in addition a brief comment on the data status for each NFC, for the reporting year, with respect to the parameter assessed and including analyses of spatial variability of data and temporal trends of parameters.

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