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

Further development and implementation of an EU-level Forest Monitorng System (FutMon)

Forest Condition in Europe

2011 Technical Report of ICP Forests and FutMon

Work Report of the:

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2011 Technical Report of ICP Forests and FutMon

Richard Fischer, Martin Lorenz (eds.)

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United Nations Economic Commission for Europe (UNECE)
Convention on Long-Range Transboundary Air Pollution CLRTAP
International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests)
www.icp-forests.org

Further development and implementation of an EU-level Forest Monitorng System (FutMon)
www.futmon.org

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Cover photos: Dan Aamlid (landscape, top), Richard Fischer (middle) Silvia Stofer (bottom)

Table of Contents

Part III ELEMENT FLUXES

Part IV CARBON AND CLIMATE CHANGE

Part V BIODIVERSITY

Part VI NATIONAL SURVEYS

Preface

Forests provide a wealth of benefits to the society but are at the same time subject to numerous natural and anthropogenic impacts. For this reason several processes of international environmental and forest politics were established and the monitoring of forest condition is considered as indispensable by the countries of Europe. Forest condition in Europe has been monitored since 1986 by the International Co-operative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) in the framework of the Convention on Long-range Transboundary Air Pollution (CLRTAP) under the United Nations Economic Commission for Europe (UNECE). The number of countries participating in ICP Forests has meanwhile grown to 41 including Canada and the United States of America, rendering ICP Forests one of the largest biomonitoring networks of the world. ICP Forests has been chaired by Germany from the beginning on. The Institute for World Forestry of the Johann Heinrich von Thünen-Institute (vTI) hosts the Programme Coordinating Centre (PCC) of ICP Forests.

Aimed mainly at the assessment of effects of air pollution on forests, ICP Forests provides scientific information to CLRTAP as a basis of legally binding protocols on air pollution abatement policies. For this purpose ICP Forests developed a harmonised monitoring approach comprising a large-scale forest monitoring (Level I) as well as a forest ecosystem forest monitoring (Level II) approach laid down in the ICP Forests Manual. The participating countries have obliged themselves to submit their monitoring data to PCC for validation, storage, and analysis. The monitoring, the data management and the reporting of results used to be conducted in close cooperation with the European Commission (EC). EC co-financed the work of PCC and of the Expert Panels of ICP Forests as well as the monitoring by the EU-Member States until 2006.

While ICP Forests - in line with its obligations under CLRTAP - focuses on air pollution effects, it delivers information also to other processes of international environmental politics. This holds true in particular for the provision of information on several indicators for sustainable forest management laid down by Forest Europe (FE). The monitoring system offers itself for being further developed towards assessments of forest information related to carbon budgets, climate change, and biodiversity. This is accomplished by means of the project “Further Development and Implementation of an EU-level Forest Monitoring System” (FutMon). FutMon is carried out from January 2009 to June 2011 by a consortium of 38 partners in 23 EU-Member States, is also coordinated by the Institute for World Forestry of vTI, and is co-financed by EC under its Regulation “LIFE+”. FutMon revises the monitoring system in close cooperation with ICP Forests. It establishes links between large-scale forest monitoring and National Forest Inventories (NFIs). It increases the efficiency of forest ecosystem monitoring by reducing the number of plots for the benefit of a higher monitoring intensity per plot. This is reached by means of a higher number of surveys per plot and newly developed monitoring parameters adopted by ICP Forests for inclusion into its Manual. Moreover, data quality assurance and the database system are greatly improved.

Given the current cooperation between ICP Forests and FutMon, the present Technical Report is published as a joint report of both of them.

2. Quality Assurance and Quality Control within the monitoring system

Marco Ferretti[1], Nils König[2], Oliver Granke[3], Nathalie Cools[4], John Derome(†)[5], Kirsti Derome[5], Alfred Fürst[6], Friedhelm Hosenfeld[7], Aldo Marchetto[8], Volker Mues[3]

2.1 The overall quality assurance perspective

The need for a comprehensive Quality Assurance (QA) programme in ecological monitoring has been reported several times (e.g. Crumbling, 2002; Ferretti, in press; Ferretti, 2009). Since 2007 a concept for a new QA perspective has been developed and implemented within the ICP Forests (Ferretti et al., 2009). This concept includes four main pillars: (i) the revision and harmonization of the Standard Operative Procedures (SOPs, i. e. the Manual); (ii) a new set of Data Quality Requirements (DQRs), explicitly incorporated in the SOPs; (iii) an extended series of training sessions and (iv) inter-comparison rounds. The SOPs have been revised in 2009 and 2010 with the support of the Life+ FutMon project, and this process has resulted in the comprehensive revision of the ICP Forests Manual (ICP-Forests 2010). One of the main aims of this revision process was to identify DQRs for a series of key monitoring variables covering all the investigations carried out within the ICP Forests. For such variables, DQRs have been identified in terms of Measurement Quality Objectives (MQOs) and Data Quality Limits (DQLs). MQO is the expected level of precision/accuracy for individual observations; DQL is the minimum acceptable frequency of observation that should be within the MQOs.

This comprehensive QA approach resulted in a much higher share of variables for which data quality requirements have been specified (Fig. 2-1). ICP Forests measurements cover approximately 260 different variables. Prior to the FutMon project and the manual revision, the share of variables covered by DQRs was 33%. Afterwards, the coverage was extended to 66% of the variables. In practical terms, it means that it is now possible to document and report on data quality for 2/3 of the variables measured within the ICP Forests. It is worth noting that – besides laboratory measurements that were traditionally given more attention with respect to data quality (see below) – field measurements like tree condition, ground vegetation, litterfall, ozone injury, tree growth and phenology are now covered by explicit DQRs.

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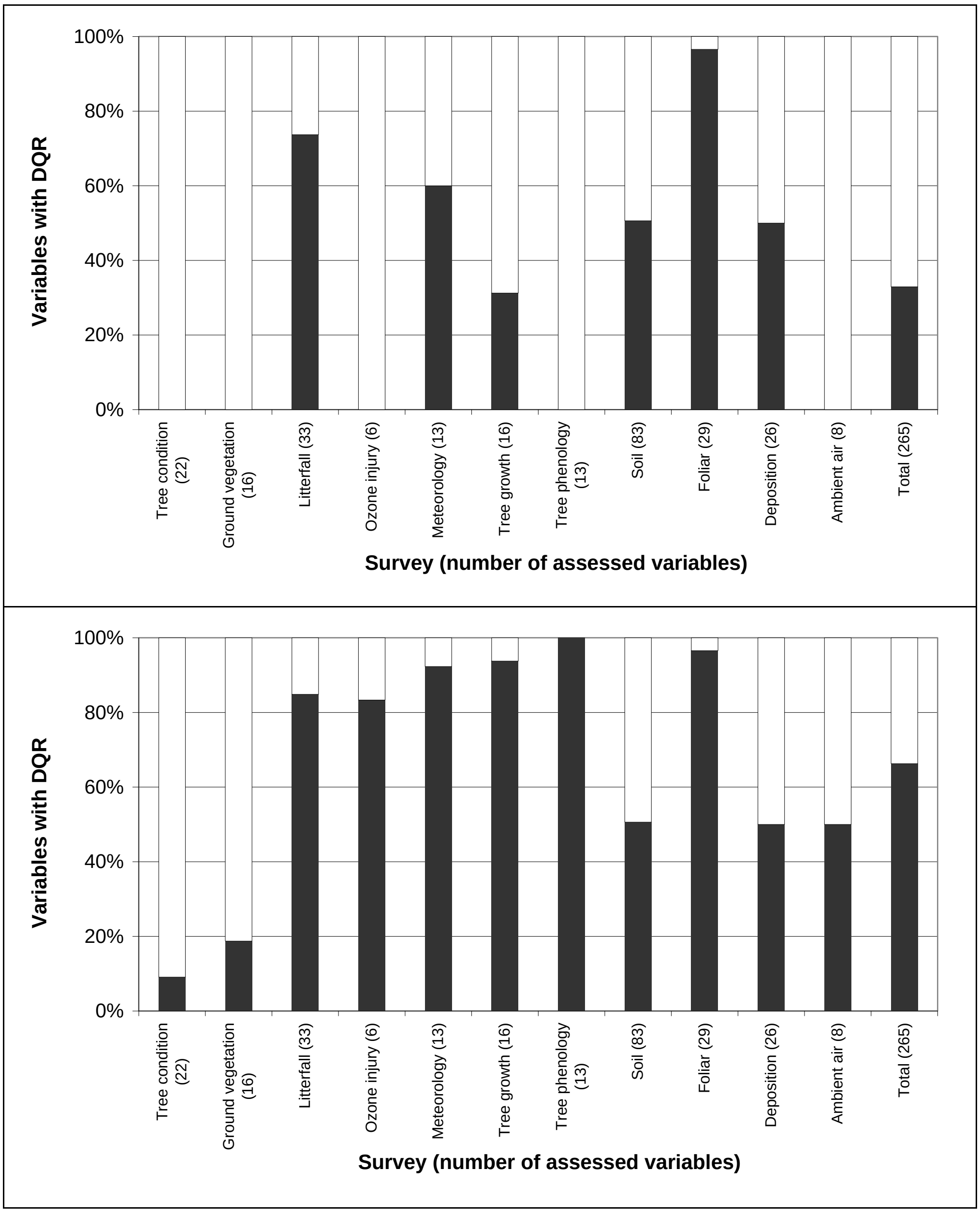

Figure 2-1: Frequency (%) of variables with (black) and without (white) DQRs before (top) and after (bottom) the development of the new QA approach and the revision of the ICP Forests Manual carried out within the FutMon project.

However, a sound data quality concept must go beyond the metrological quality of the data (i.e. the quality of measurements, which is of course important – see below) and should address all the steps before and after the measurements (Crumbling, 2002). While the steps after the measurements are being considered by the database managers, quality issues related to sampling in the field need to be tackled in the near future. This will be a further, major step ahead in promoting the overall data quality within the ICP Forests.

2.2 Quality improvement in the laboratories

The Working Group on Quality Assurance and Quality Control in Laboratories was installed within the ICP Forests in the year 2004 in order to improve the comparability and evaluability of the analytical data of the ICP Forests program and later also of the FutMon project. The aims of this group are

- the evaluation of analytical methods used in terms of their comparability and acceptability and the elimination of unqualified methods
- the amendment of the ICP Forests Manuals with information on methods for sample pretreatment and analysis
- the development and introduction of new methods for quality control in the laboratories
- the organization of practical help for laboratories with analytical problems and
- the organization of ring tests to control the development of quality in the laboratories.

After several years of work the analytical parts of the ICP Forests manual have been totally revised and unqualified methods have been eliminated. A review of possible checks and other helps for quality assurance and control in laboratories has been compiled and published. Two meetings of the heads of the laboratories have been organized to exchange analytical knowledge and discuss analytical problems and possible solutions. A helping program for laboratories with problematic ring test results has been organized with bilateral visits of the laboratories and active help. In the meantime 10 laboratories have made use of this possibility with great success. The use of reference methods, different quality checks like control charts or ion balance calculations and the participation in ring tests has become mandatory within the ICP Forests program and the FutMon project. Nowadays, each laboratory involved in the program has to send filled quality forms with information on methods used, on quantification limits, use of control charts and ring test results when submitting analytical data to the ICP Forests database.

The most important step to improve quality assurance and control was the introduction of regular ring tests for water, soil and plant samples. It is worth noting that, before the installation of the Working Group, such ringtests had been conducted only on an irregular basis. In the meantime 6 soil, 4 water and 12 foliar ring tests have been organized within the ICP Forests program and the FutMon project. The results of these ring tests show the development of data quality in the laboratories. In water ringtests, the percentage of results outside the tolerable limits has been reduced from 20-60% to 5-30% over 8 years (Fig. 2-2). A similar improvement can be seen for the results of the last 4 soil ring tests (Fig. 2-3): the coefficient of variation (CV in %) for the results of all participants has been reduced from 15-65% to 10-35% over 7 years. For the foliar ring tests (Fig. 2-4) only 3-10% of the results were beyond the tolerable limits already in 2005. This excellent level has been maintained in the following five tests.

Ring test results suggest a lower comparability and quality of the soil analysis data as compared to water and plant analysis data. One reason may be that soil analyses are regularly carried out in much longer intervals; another reason is that the soil matrix is much more complex to analyse. In contrast to water and foliar analysis, element analyses do not concern total analyses but fractions, which are much more difficult to measure accurately. And the soil analyses mostly are of two steps (e.g. digestion or extraction and measurement) which in turn double possible mistakes. But it is obvious that as well the quality of water analyses can still be improved. Therefore regularly ring tests are still important for the improvement of the quality of analyses in the ICP Forests programme.

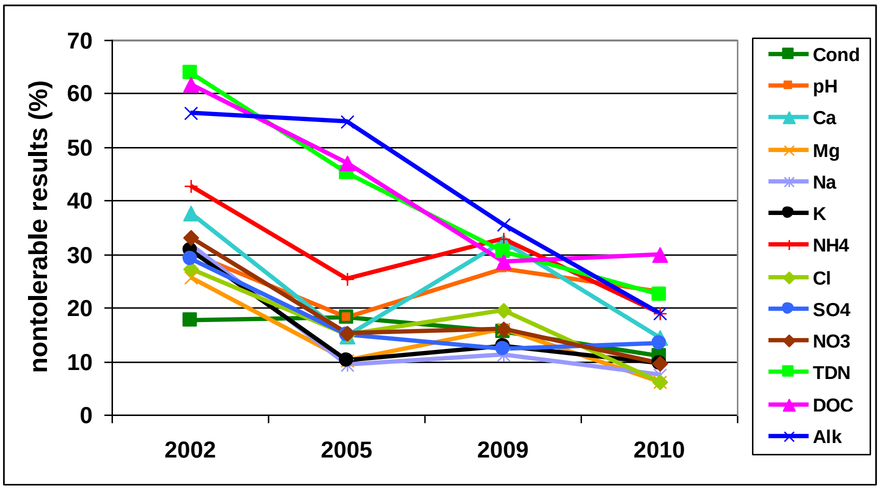

Figure 2-2: Development of the non tolerable results of the ICP Forests/FutMon water ring tests 2002 – 2010 for all evaluated parameters

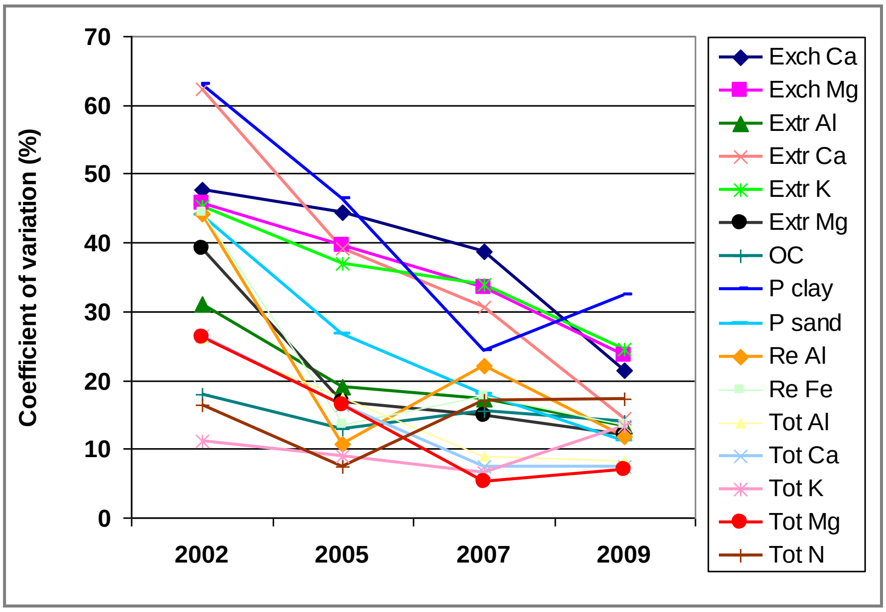

Figure 2-3: Development of the coefficient of variation (CV, in%) for selected parameters of the ICP Forests/FutMon soil ring tests (RT) 2002 – 2009

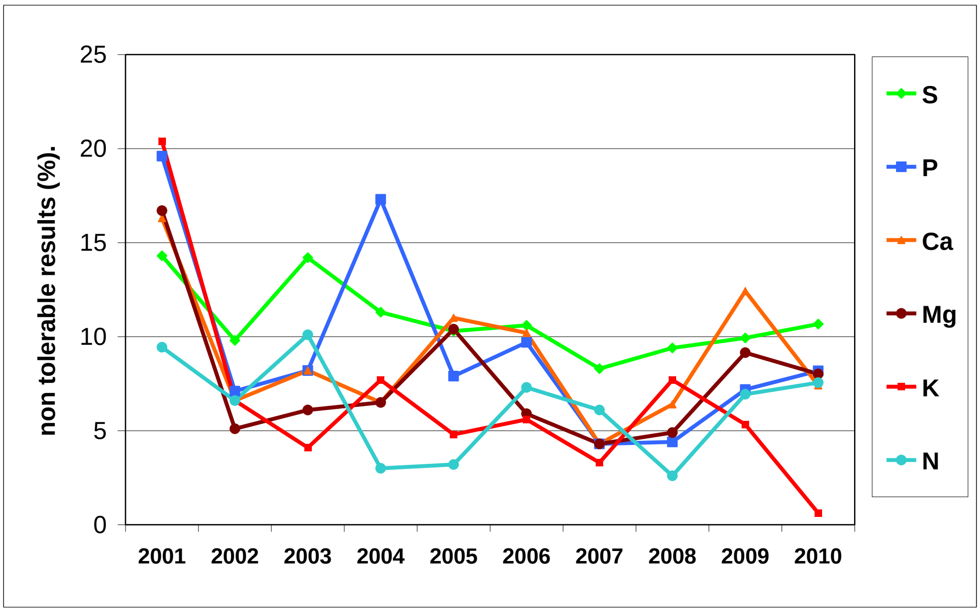

Figure 2-4: Development of the non tolerable results of the ICP Forests/FutMon foliar ring tests 2001 - 2010 for the mandatory parameters (foliage samples)

2.3 Quality control in the data base

Co-financed by the FutMon project, a new web-based system for data submission, storage, dissemination and evaluation was set up in the years 2009 and 2010. Central data management is an essential tool to control and document data quality. Only by means of comprehensive validations and consistency checks improved data quality can be achieved and fully documented: this facilitates extensive and effective data evaluations for project partners and third parties. A wide range of validation rules help to control data compliance and conformity using online and real-time checks. In addition, the newly designed system offers an administration area including functions to monitor data submission processes, to inspect and compare the managed data using tables, digital maps as well as diagrams.

In the database, three modules support data analysis and checks after import. These are compliance, consistency and uniformity checks which are subsequently applied (Fig. 2-5) (Durrant Houston and Hiederer, 2009).

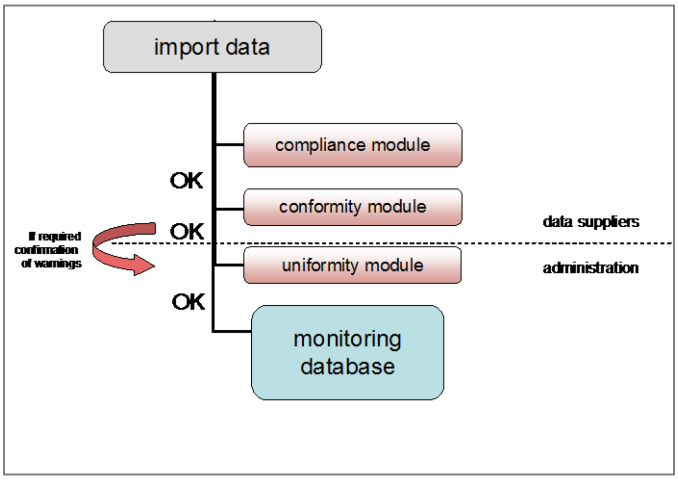

Figure 2-5: Subsequent application of data checks

2.3.1 Compliance checks

The compliance module analyses file structure based on data type, field lengths, mandatory information as well as completeness of the file. In real-time, data suppliers receive pdf test reports documenting results of the checks. Errors need to be corrected offline and only after successful resubmission the data submission process can be continued by the user.

2.3.2 Conformity checks

In a second step, data are checked for conformity by a number of additional tests. This module is currently based on 682 defined data rules.

- Primary key properties check for data gaps or duplicates.
- Simple range checks are defined by lower and upper limits that may not be exceeded by single parameters.
- Multiple parameter checks analyse parameters with regard to contradictions or implausibility. These checks can be based on parameters within the same data submission file as well as on parameters from different files and even different surveys.
- Temporal consistency checks compare data with values of previous years.
- Spatial comparisons check whether the spatial details of the plots are defined according to pre-defined specifications.
- Additional parameter specific rules can be applied for checks that are not covered by the previous ones.

Also for these tests results are automatically documented in a pdf report and submission can only be continued if no more errors occur.

2.3.3 Uniformity checks

When data submission is complete for single years and countries, various uniformity analyses are performed by the data managers. This includes plausibility checks for spatial and temporal consistency. Dynamically generated tables, diagrams and digital maps support these steps. A WebGIS module offers dynamic spatial evaluations complemented by time series diagrams (Fig. 2-6). In the current version, data managers can select from 866 dynamic maps. The combination of spatial and time-based visualization enables the identification and further analysis of implausible values. Problematic data records can require re-submission of the affected data files or manual correction of single values.

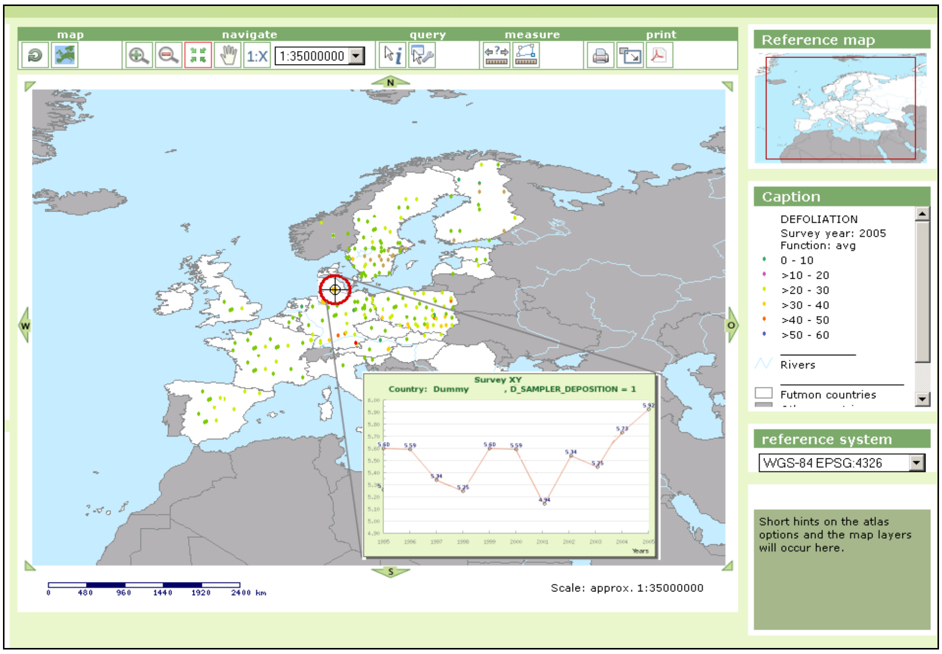

Figure 2-6: WebGIS module

2.3.4 Experience with improved data base system

Within the monitoring programme the acceptance by the users was very high so that data acquisition and data quality could be improved. Immediate feedback from compliance and conformity checks has proven essential in order to fix data errors promptly and to increase the motivation of data suppliers. Time necessary for data transmission has been considerably reduced. With the new system, legacy data from previous monitoring years were checked as well and numerous inconsistencies in existing legacy data were detected and corrected.

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