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Assessment and Monitoring of Air Pollution
Effects on Forests (ICP Forests)



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

Forest Condition in Europe

2011 Technical Report of ICP Forests and FutMon

Work Report of the:

Johann Heinrich von Thünen-Institute
Institute for World Forestry



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Forest Condition in Europe

2011 Technical Report of ICP Forests and FutMon

Richard Fischer, Martin Lorenz (eds.)

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

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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.

1. Background, set-up and current state of the ICP Forests and FutMon monitoring system

Martin Lorenz¹ and Oliver Granke¹

1.1 Background

Forest monitoring in Europe has been conducted for 26 years according to harmonised methods and standards by the International Cooperative Programme on Assessment and Monitoring of Air Pollution effects on Forests (ICP Forests) of the Convention on Long-range Transboundary Air Pollution (CLRTAP) under the United Nations Economic Commission for Europe (UNECE). The monitoring results meet the scientific information needs of CLRTAP for clean air policies under UNECE. According to its strategy for the years 2007 to 2015, ICP Forests pursues the following two main objectives:

1. To provide a periodic overview of the spatial and temporal variation of forest condition in relation to anthropogenic and natural stress factors (in particular air pollution) by means of European-wide (transnational) and national large-scale representative monitoring on a systematic network (monitoring intensity Level I).
2. To gain a better understanding of cause-effect relationships between the condition of forest ecosystems and anthropogenic as well as natural stress factors (in particular air pollution) by means of intensive monitoring on a number of permanent observation selected in most important forest ecosystems in Europe (monitoring intensity Level II).

The complete methods of forest monitoring by ICP Forests are described in detail in the “Manual on methods and criteria for harmonised sampling, assessment, monitoring and analysis of the effects of air pollution on forests” (ICP Forests 2010). For many years forest monitoring according to the ICP Forests Manual was conducted jointly by ICP Forests and the European Commission (EC) based of EU-cofinancing under relevant Council and Commission Regulations. The monitoring results are also delivered to processes and bodies of international forest and environmental policies other than CLRTAP, such as Forest Europe (FE), the Convention on Biological Diversity (CBD) the UN-FAO Forest Resources Assessment (FRA), and EUROSTAT of EC. In order to better meet the new information needs with respect to carbon budgets, climate change, and biodiversity, the forest monitoring system was further developed in the years 2009 to 2011 within the project “Further Development and Implementation of an EU-level Forest Monitoring System” (FutMon) under EU-cofinancing. The following chapters describe briefly the selection of sample plots and the surveys on the revised Level I and Level II monitoring networks.

1.2 Large-scale forest monitoring (Level I)

The large-scale forest monitoring grid consists of more than 7500 plots. The selection of Level I plots is within the responsibility of the participating countries, but the density of the plots should resemble that of the previous 16 x 16 km grid. For this reason, the number of

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plots in each country should be equal to the forest area of the country (in km²) divided by 256. For each country the number of those Level I plots on which crown condition was assessed within the last years is provided in Table 3-1 of Chapter 3. The spatial distribution of those plots is shown in the map in Annex I of Chapter 3.

Of all countries participating in ICP Forests, 23 EU-Member States participated in FutMon. One of the aims of FutMon was fostering synergies between Level I and other large-scale grids, mainly the National Forest Inventories (NFIs). By the end of FutMon in June 2011, 58% of the Level I plots in the EU-Member States were coincident with NFI plots. No coincidence with NFI plots was given for 29% of the plots. It is expected, however, that a number of countries will merge these plots with NFI plots at a later date. For the remaining plots no information was made available (Fig. 1-1).

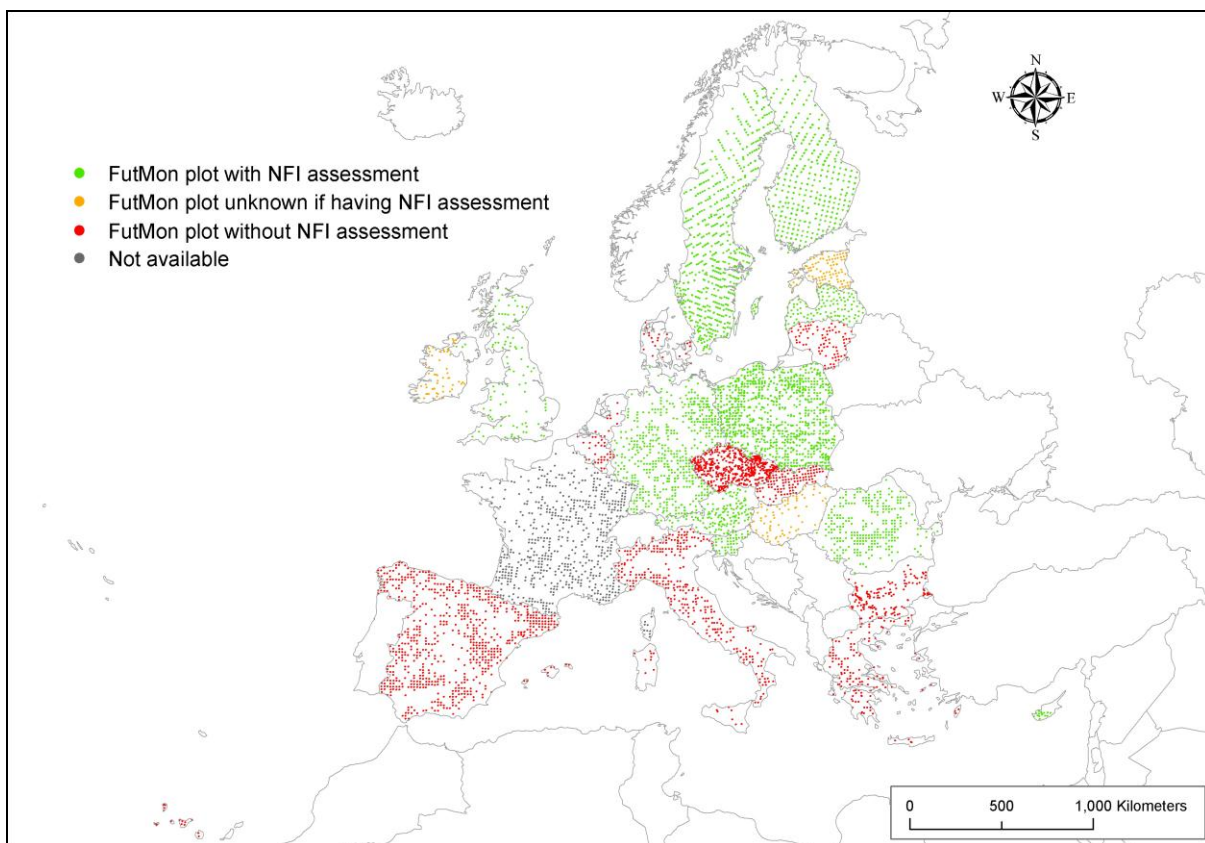


Figure 1-1: Spatial distribution of the large-scale plots under FutMon. Green colour implies a coincidence with NFI plots.

On most of the Level I plots tree crown condition is assessed every year. In 1995, element contents in needles and leaves were assessed on about 1500 plots and a forest soil condition survey was carried out on about 3500 plots. The Level I soil condition survey was repeated on about 5300 plots in 2005 and 2006 and the species diversity of forest ground vegetation was assessed on about 3400 plots in 2006 under the Forest Focus Regulation of EC within the BioSoil project (Fig. 1-2).

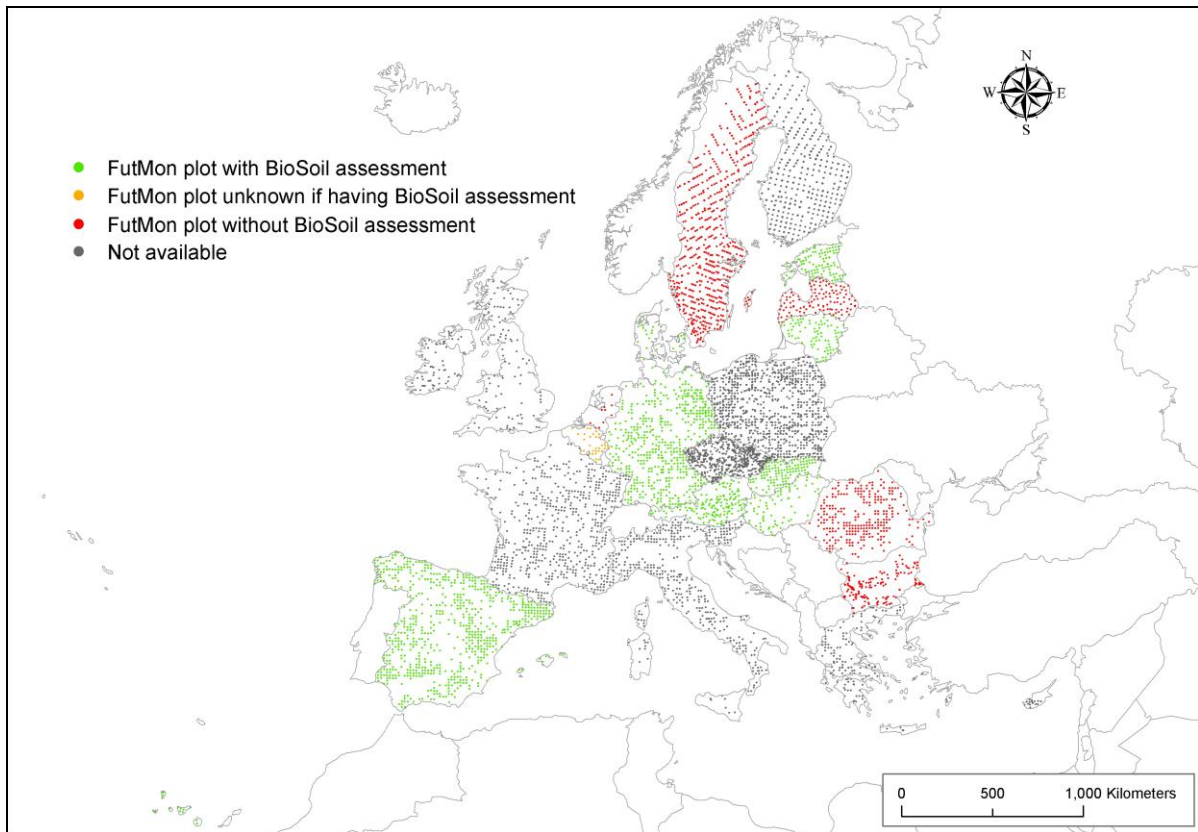


Figure 1-2: Spatial distribution of the large-scale plots under FutMon. Green colour implies inclusion in the BioSoil project under the Forest Focus Regulation of EC.

1.3 Intensive forest monitoring (Level II)

Intensive monitoring in 2009 comprised up to 17 surveys on different numbers of Level II plots depending on the survey (Tab. 1-1). Of these surveys many are not conducted continuously or annually, but are due only every few years. Moreover, on most plots only part of the surveys can be conducted. The fragmentary coverage of the plots by important surveys constituted a major problem for data analyses.

One of the aims of FutMon was to bundle resources and to reduce the number of Level II plots for the benefit of higher numbers of surveys per plot. For each survey Table 1-1 shows the number of plots from which data were submitted in 2009. Installed plots comprise those from which data are available in the data base. The map in Figure 1-3 shows those plots on which crown condition was assessed in 2009, coming close to the total of all Level II plots assessed in 2009. Moreover, the map indicates the locations of Level II plots of previous years.

Table 1-1: Surveys, numbers of Level II plots and assessment frequencies in 2009

Survey	Data submitted for 2009	Plots installed	Assessment frequency
Crown condition	559	938	Annually
Foliar chemistry	308	859	Every two years
Soil condition	68	753	Every ten years
Soil solution chemistry	196	338	Continuously
Tree growth	256	820	Every five years
Deposition	287	654	Continuously
Ambient air quality (active)	28	46	Continuously
Ambient air quality (passive)	167	377	Continuously
Ozone induced injury	123	188	Annually
Meteorology	210	327	Continuously
Phenology	188	240	Several times per year
Ground vegetation	169	815	Every five years
Litterfall	162	276	Continuously
Nutrient budget of ground vegetation	83	83	Once
Leaf Area Index	107	107	Once
Soil Water	46	46	Once
Extended Tree Vitality	115	115	Annually/ Continuously

Within FutMon Action “Intensive Monitoring 1” an increased set of surveys was bundled on so-called “IM1 plots”. Based on the experiences and outcome of FutMon the ICP Forests manual update 2010 refers to and explicitly specifies variables to be assessed on Level II standard plots. With a few changes and amendments Level II standard plots comprise the set of “IM1” surveys. Table 1-2 identifies the surveys conducted on those 252 “IM1” plots as well as the numbers of plots installed in each country. On part of these plots FutMon conducted demonstration actions D1, D2 and D3. For each of these demonstration actions Table 1-2 identifies the respective additional surveys. The ICP Forests manual update 2010 refers to and explicitly specifies variables to be assessed on Level II core plots. With a few changes and amendments Level II core plots comprise the set of “IM1+D1+D2+D3” surveys. There are approximately 100 plots on which all three demonstration actions are carried out. The plots largely correspond to Level II core plots.

In summing up, about 100 Level II core plots comprise practically all surveys and constitute a subsample of 252 Level II standard plots. The standard plots have an increased set of surveys and constitute a subsample of the total of more than 900 Level II plots. The remaining of those more than 900 plots have smaller sets of surveys with different combinations.



Figure 1-3: Level II plots with crown condition assessments in 2009. Also shown are plots with other surveys and of previous years.

Table 1-2: Numbers of plots in each country with FutMon intensive monitoring (IM1) and demonstration actions D1, D2 and D3 during the FutMon project period (2009-2011)

Country	2009-2011			
	IM1*	D1**	D2 ⁺	D3 ⁺⁺
Austria	15	6	6	6
BE-Flanders	5	5	5	5
Bulgaria	3		3	
Cyprus	2			
Czech Republic	14	4	10	10
Denmark	6	3	6	6
Estonia	7		5	
Finland	18	18	18	18
France				
Germany	44	37	44	36
Greece	4	3	3	3
Hungary	8	8	2	
Ireland	3	3	3	
Italy	22	5	22	5
Latvia	1			
Lithuania				
The Netherlands	5			
Poland	12			
Romania	4	4	4	4
Slovakia	8	4	4	4
Slovenia	10	6	2	6
Spain	13	13	13	7
Sweden	12		12	
United Kingdom	10	4	6	4
Total	252	140	195	124

* Assessments within IM 1 (Intensive Monitoring 1) include:
 Crown condition
 growth (once)
 Foliar chemistry (once)
 Ground vegetation (once)
 Deposition
 Ambient air quality
 Visible ozone injury;
 Soil (unless already assessed under BioSoil)
 Meteorology

** Assessments within D1 (demonstration project 1) include:
 Intensified crown condition assessments
 growth (continuous)
 Litterfall (foliage and fruiting compartments)
 Phenology
 Leaf area index (new)

⁺ Assessments within D2 (demonstration project 2) include:
 Litterfall (mass and element concentrations)
 Soil solution
 Intensified foliar surveys (new)
 Nutrient budgets of ground vegetation (new)

⁺⁺ Assessments within D3 (demonstration project 3) include:
 soil volumetric water content (new)
 matrix potential (new)
 stand precipitation (new)
 leaf area index (new)
 soil temperature (new)
 determination of water retention functions in the lab (new)