LRTAP
Long-range Transboundary Air Pollution

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

The Condition of Forests in Europe

2008 Executive Report

Prepared by:
Institute for
World Forestry

World Forestry

Hamburg, 2008

ISSN 1020-587X
Printed in Germany
Layout by www.stueber-graphik.de

The Condition of Forests in Europe

2008 Executive Report

United Nations Economic Commission for Europe,
Convention on Long-range Transboundary Air Pollution,
International Co-operative Programme on Assessment
and Monitoring of Air Pollution Effects on Forests (ICP Forests)

Acknowledgements

The ICP Forests wishes to express its appreciation to all persons and institutions that have contributed to the preparation of the report:
in particular the Johann Heinrich von Thünen-Institute (vTI), Federal Research Institute for Rural Areas, Forestry and Fisheries, Institute for World Forestry – Programme Coordinating Centre of ICP Forests – and the National Focal Centres for supplying the data

and the authors
Richard Fischer, Martin Lorenz, Michael Köhl, Georg Becher, Oliver Granke, Andreas Christou

as well as
Nicholas Clarke (linguistic revision)

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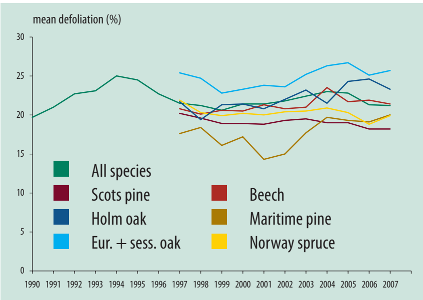
The ICP Forests monitoring programme was established in 1985 under the auspices of the Convention on Long-range Transboundary Air Pollution. A close collaboration with the European Commission began in 1986. Today, 41 countries participate in the programme. Results are based on around 6 000 Level I and 800 Level II plots.



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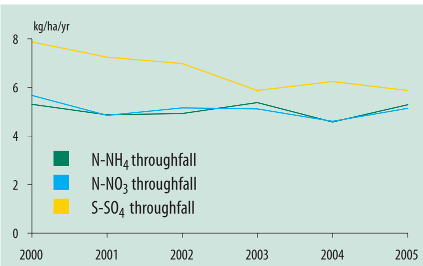
Pinus brutia is a tree species typical for the eastern Mediterranean basin. It is well adapted to drought and fire.

Brutia pine forests have been overexploited in the past for timber, fuel and shipbuilding. Today, the remaining forest ecosystems are important for multiple purpose forestry and have a very high ecological and conservation value, as has been shown on ICP Forests monitoring plots.



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ICP Forests has developed into one of the largest forest monitoring networks in the world. With its long time series of multidisciplinary monitoring data the programme provides essential information for the understanding of impacts of environmental changes on forest ecosystems in Europe. Though focussing on air pollution effects on forests the programme plays a key role in the further development of forest monitoring in Europe in order to meet the new challenges of climate change and biodiversity loss.

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Michalis Poliniki Charalampides

Preface

It is a great privilege and pleasure for me to contribute with this preface to the 2008 Executive Report on Forest Condition in Europe.

We all know that forestry today is becoming one of the most important socio-economic and environmental issues world-wide. Throughout the world, forests have many important functions. They are a basis for economic activity, and play a significant role in the development of rural areas and for recreational purposes. Forests have major value for nature conservation and environmental protection and are significant carbon sinks, and thus relevant in the context of climate change. Forests also represent a controlling factor within the water cycle.

In Europe, where forests cover almost half of the land surface, forests constitute an integral part of its environment and nature, economy, rural development and recreation. The state of the forests became a matter of particular concern in the early 1980s, when the condition of forest tree crowns was observed to deteriorate in large parts of Europe. This was mainly attributed to air pollution. Since then, new and old hazards are threatening and damaging forest ecosystems. Among these threats, the most important are forest fires, air pollution, and high levels of ground level ozone. Globally, climate change is a major threat. According to the climate models, changes in average temperatures and precipitation will strongly affect ecological conditions of forests and their biodiversity and plant communities. In addition, extreme weather events like storms, high temperatures and long lasting droughts will probably occur much more often in the future with negative consequences for forests.

Sustainable forest management, as well as environmental policies, relies upon the sound scientific resource provided by long-term, large scale and intensive monitoring of forests. The International Co-operative Programme on the Assessment and

Cedar forest, Cyprus.

Monitoring of Air Pollution Effects on Forests (ICP – Forests) with its National Focal Centres under the framework of the UN Economic Commission for Europe, in good co-operation with the European Commission, have provided much relevant information on the large – scale spatial and temporal variation of forest condition. This has been achieved by using a European – wide network of Level I plots, as well as studying cause – effect relationships at the ecosystem scale by means of intensive monitoring at Level II plots. At Level II plots, the nutrient status of soil and trees, increment, vegetation, deposition, soil solution and other parameters are assessed in addition to crown condition. Today, 41 countries are participating in the programme and the data and results of the monitoring activities are of great importance in formulating forest and environmental policies by providing information for a number of criteria and indicators for sustainable forest management, as defined by the Ministerial Conference on the Protection of Forests in Europe (MCPFE). Contributions to the Convention on Biological Diversity (CBD) have been made as well.

The results of ICP–Forests provide not only a realistic picture of the extent and development of forest damage, but increase our knowledge on the status of forest ecosystems in Europe, on the effect of atmospheric deposition and other stress factors. They contribute to the elucidation of the complex causes and effects involved. ICP – Forests promotes the wide use of its data for scientific evaluation. Upon request and in agreement with the data owners, data are free for external users.

We have to keep in mind that besides the joint monitoring activities of ICP-Forests and EU, there are National Forest Inventories and other regional environmental programmes contributing to the better understanding and management of forests. The integration and combination of all these activities seems to be the best and most effective approach to derive forest related information at the European scale. Such an integrated project proposal has been prepared and submitted under the "LIFE+" Regulation (EC No 614/2007).

Michalis Poliniki Charalampides
Minister of Agriculture,
Natural Resources and Environment

Meteorological measurement station and litterfall sampler in a Nordic spruce forest.

1. The pan-European forest monitoring programme

Data for forest management and policy making

One third of Europe's land surface is covered by forests, with important economic and social values. Over large areas they constitute the most natural ecosystems of the continent. Sustainable forest management, as well as environmental policies, must rely upon the sound scientific resource provided by long-term, large-scale and intensive monitoring of forest condition.

Monitoring for the long term

In 1985, the International Co-operative Programme on the Assessment and Monitoring of Air Pollution Effects on Forests (ICP Forests) was established. The programme operates under the UNECE Convention on Long-range Transboundary Air Pollution (CLRTAP) and regularly provides information on the condition of forests in Europe as a basis for the development of air pollution abatement strategies. It is, in addition, a platform for information exchange for forest scientists, managers and politicians of 41 participating countries including Canada and the USA.

Part of a collaborative network

Since 1986, the ICP Forests has been closely cooperating with the European Union. Up to the year 2006 this cooperation has been based on specific regulations. The "Forest Focus" regulation (EC No 2152/2003) was the last of these regulations and constituted the legal basis for the co-financing of monitoring activities until 2006. Since its adoption, the "LIFE+" Regulation (EC No. 614/2007) has been the legal basis for co-financing of the future development of forest monitoring in the European Union.

The data and results of the monitoring activities provide information for a number of criteria and indicators for sustainable forest management as defined by the Ministerial Conference on the Protection of Forests in Europe (MCPFE). Contributions to the Framework Convention on Climate Change (FCCC) and to the Convention on Biological Diversity (CBD) have been made too. The programme also maintains close contacts with the Acid Deposition Monitoring Network in East Asia (EANET).

Challenging objectives and a unique monitoring system

One objective of the ICP Forests is to assess the status and development of the health and vitality of European forests on a large scale. Air pollution effects are the particular focus of the programme. Data are collected by the participating countries on up to 6 200 permanent observation plots called Level I. These plots are located on a 16x16 km grid covering 33 countries throughout Europe (see Tab. 1-1). In addition to annual crown condition surveys, the BioSoil demonstration project conducted in 2006 enabled a repeat of an original soil survey undertaken in 1994 in many European countries.

In order to detect the influence of various stress factors on forest ecosystems, intensive monitoring is carried out on more than 800 Level II plots (see Tab. 1-2). These plots are located in forests that represent the most important forest ecosystems of the continent.

Further information:
http://www.icp-forests.org

	Frequency	Number of plots with data	Number of plots; data submission 2007
Crown condition	Annually	8388*	4834
Foliar chemistry	Once until now	1497	-
Soil chemistry	Once until now; (repetition ongoing in most of the EU countries within the BioSoil project)	5289 (4000)	-
Tree growth	Demonstration project ongoing (BioSoil)		
Ground vegetation	Demonstration project ongoing (BioSoil)		
Stand structure, deadwood	Demonstration project ongoing (BioSoil)		

Table 1-1: Surveys and number of plots on Level I

* this includes discontinued plots as well

	Frequency	Number of plots with data	Number of plots with data submission 2006
Crown condition	Annually	822	662
Foliar chemistry	Every 2 years	795	150
Soil chemistry	Every 10 years	742	0
Tree growth	Every 5 years	781	77
Ground vegetation	Every 5 years	757	119
Stand structure incl. deadwood	Once	90	0
Epiphytic lichens	Once	90	0
Soil solution chemistry	Continuously	262	241
Atmospheric deposition	Continuously	558	437
Ambient air quality	Continuously	121	121
Meteorology	Continuously	235	235
Phenology	Several times per year	152	152
Litterfall	Continuously	145	145
Remote sensing	Preferably at plot installation	National data	0

Table 1-2: Surveys and number of plots on Level II (see Annex III for more details)

Slightly defoliated beech crown. Defoliation is estimated as percentage of leaf or needle loss and is used to assess forest health and vitality.

2. Tree crown defoliation has fluctuated in recent years.

Summary

- *Crown defoliation is a valuable indicator for the condition of forest trees. It reflects, among other influences, weather conditions and the occurrence of insects and fungal diseases. Such information is extremely relevant in order to follow reactions of forest ecosystems to climate change and to ensure sustainable forest management in the future.*
- *In 2007, one fifth of the assessed trees were rated as damaged, just like in 2006. This shows some recuperation after the deterioration of forest condition related to the extremely dry and warm summer of 2003.*

Crown condition is a major indicator for forest health in Europe

The condition of forest trees in Europe is monitored over large areas by a survey of tree crown defoliation. Defoliation is a fast reacting indicator for numerous natural and anthropogenic factors affecting tree vitality. It is therefore not only of high relevance to ICP Forests, as the Ministerial Conference on the Protection of Forests in Europe (MCPFE) uses defoliation as one of four indicators for forest health and vitality.

The crown condition survey on the large-scale transnational 16x16 km grid in 2007 comprised 4 834 plots in 27 countries. In all, 104 361 trees were assessed. The present report focuses on those tree species represented most frequently on the plots, i.e. Scots pine, Norway spruce, common beech, and European and sessile oak, the latter two oak species being evaluated as one.

Trends in mean defoliation vary between tree species and regions

In 2007, 21.9% of all trees assessed had a needle or leaf loss of more than 25% and were thus classified as either damaged or dead (see Fig. 2-1). Of the most frequent tree species, European and sessile oak had the highest share of damaged and dead trees, namely 35.2%.

Since 1990, mean defoliation of all tree species was highest in 1994 (see Fig. 2-2). In the following years, mean defoliation decreased and has fluctuated over the last decade. The warm and dry summer occurring in large parts of central Europe in 2003 led to increased defoliation in 2004. In the last year there was no remarkable change in the mean of all species. Regarding the total of all tree species, there has been no significant change in mean defoliation on 61% of the plots since 1997. However, the share of plots with increasing defoliation was higher than the share of plots with a decrease (see Fig. 2-3).

Defoliation trends for different tree species and regions differ substantially from the mean trend. Scots pine is the most frequently occurring tree species on the observation plots. It has been showing an overall improvement in crown condition since 1997, which mainly reflects a trend on plots in central-eastern Europe. A certain worsening in pine defoliation occurred in the Mediterranean region until 2006 and an improvement was registered in the last year. In northern Europe Scots pine defoliation has been fluctuating at a comparatively low level. For Norway spruce, the overall trend shows a slight improvement since 1997. However, spruce trees showed higher defoliation in central Europe after the dry and warm summer in 2003. In 2007, there was some increase in mean defoliation of spruce trees in most regions of Europe. Defoliation of common beech peaked in 2004, with a subsequent recovery. Highest defoliation of European and sessile oak was observed in 2005. The condition of these species is characterised by a certain recuperation in 2006 and another increase in 2007. Mean defoliation of deciduous oak was higher than that of all other main tree species.

Further information:
Lorenz, M.; Fischer, R.; Becher, G.; Granke, O.; Seidling, W., Ferretti, M., Schaub, M., Bacaro, G., Gerosa, G., Rocchini, D., Sanz, M. (2007) Forest Condition in Europe. 2008 Technical Report. Institute for World Forestry, Hamburg, 101 pp., Annexes. http://www.icp-forests.org/RepTech.htm

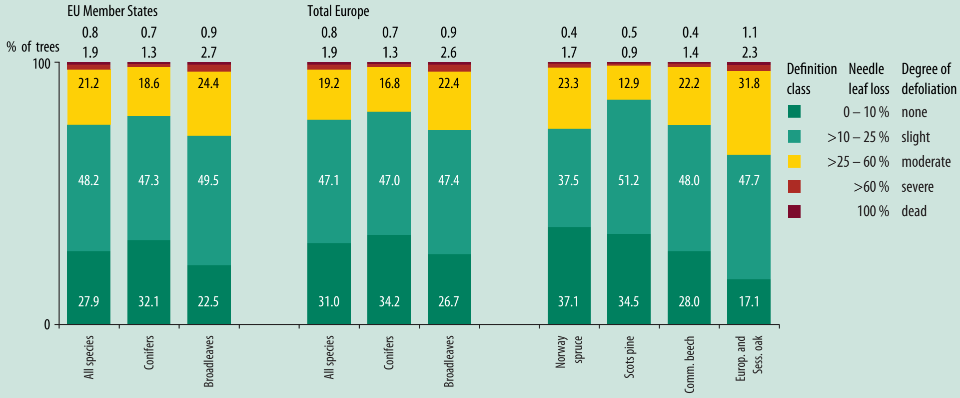

Figure 2-1: Percentage of trees in different defoliation classes. Total Europe and EU, 2007. Sample size for total Europe is 104 399 trees and for the EU 82 467 trees.

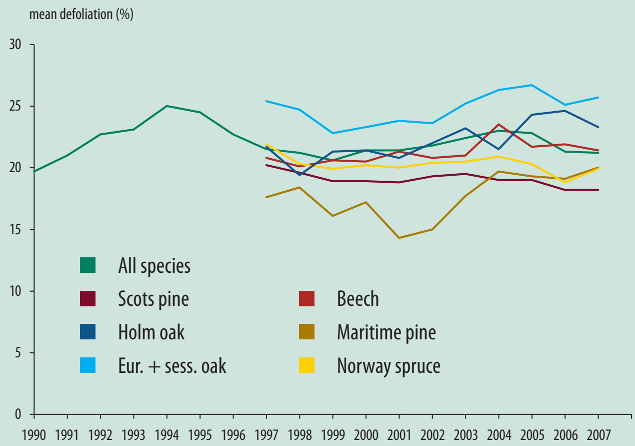

Figure 2-2: Mean defoliation for the most frequent tree species and for the total of all tree species. Samples only include countries with continuous data submission. Sample size for the selected main tree species varies between 1 950 and 26 788 trees per species and year. The time series starting in 1990 is available for a smaller number of countries and is based on between 38 026 and 45 204 trees depending on the year.

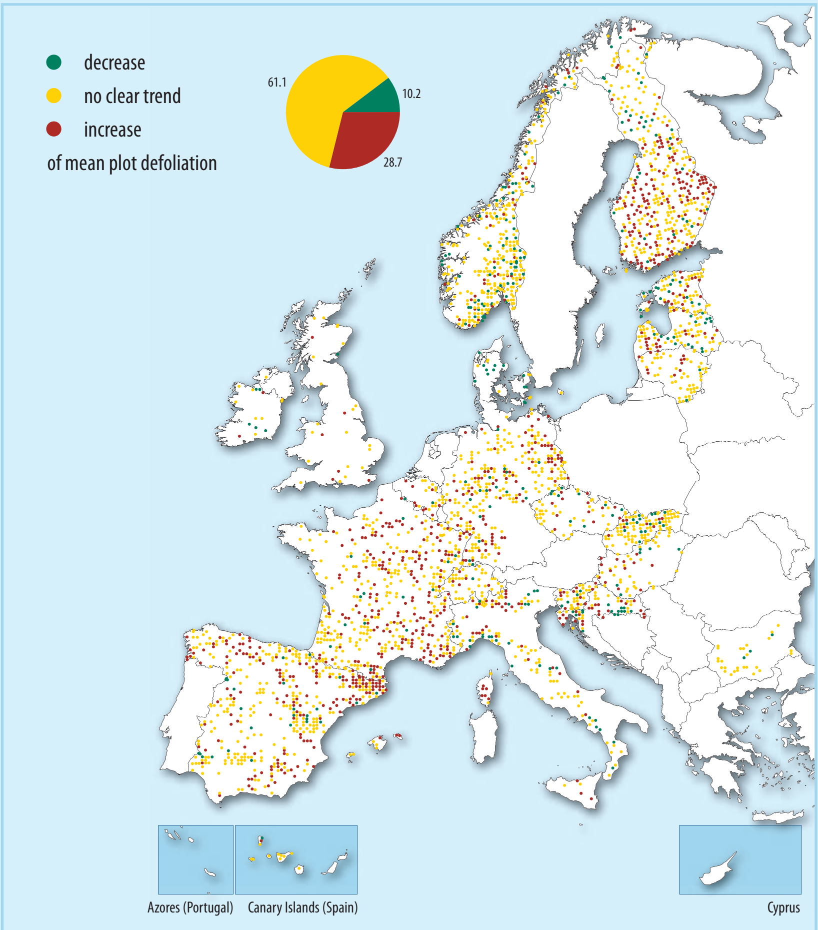

Figure 2-3: Plotwise development of defoliation for all tree species, 1997-2007. In some countries and regions of Europe, shifts in plot locations and a restructuring of the monitoring systems hinder the calculation of plotwise changes.

Extensive natural forest of *Pinus brutia* in Cyprus.

Brutia Pine Forests in the Mediterranean Basin

Brutia pine forests are typical for the eastern Mediterranean region

Pinus brutia is an eastern Mediterranean pine species, naturally widely distributed in Greece and its Aegean islands (Chios, Lesvos, Samos, Thasos, Karpathos, Kos, Rhodes and Crete), in southern and western Turkey, in Cyprus, in Lebanon and in western Syria. It has been introduced in a number of Mediterranean countries for reforestation and research purposes.

Fossil records show that *Pinus brutia* had a wider distribution in the Tertiary age. Its current distribution is a result of geological history and changes of climate during and after the glaciation in Europe. These factors, together with anthropogenic impact, contributed to the fragmentation and isolation of the species. Total forest cover of *Pinus brutia* and its subspecies today is estimated to be over four million hectares, of which over three million are in Turkey.

Pinus brutia occurs in typical Mediterranean climate but also under more continental conditions. The precipitation within its range varies from 300 mm to more than 1000 mm. In some areas there is almost no rainfall from May to September. The species can also cope with a wide range of temperatures and in some areas it survives temperatures as low as -24°C. It grows on an extremely wide range of geological substrates and soil types, from sea level up to an elevation of 1500 metres.

Brutia pine forms extensive pure and mixed stands with other conifers, mainly *Pinus nigra, Abies cilicica, Cedrus* spp., *Cupressus sempervirens* and *Pinus halepensis*. Most stands are characterized by a dense understory of Mediterranean sclerophyllous shrubs making them extremely flammable. At the upper range of its distribution it can constitute the timberline, or can occur in mixed pine-oak forests. It is an element of high maquis vegetation where it is found in small groups or with scattered individuals. Here it is considered as a remnant tree element of previous extensive forests of *Pinus brutia*.

Only remnants of the previously extensive forests still exist today

From historical and classical times until recently, Brutia pine forests have been overexploited for timber, fuel and shipbuilding but also by clear cutting for agriculture Also, catastrophic fires and grazing contributed to the depletion of the previously extensive forests. Only in the most recent decades have management plans been set up and conservation measures undertaken to ensure their sustainable use. *Pinus brutia* ecosystems are important for multiple purpose

Pinus brutia plantations in semi-arid environment in Cyprus.

forestry and have a very high ecological and conservation value. They are of high economic importance in some countries, while also providing important indirect benefits such as protection of soil and water resources, conservation of biological diversity, support to agricultural productivity, carbon sequestration and mitigation of global warming and combating desertification. Due to the ecological importance of *Pinus brutia* ecosystems, extensive areas have been included in "NATURA 2000" sites (Dir. 92/ 43/ EEC).

Pinus brutia is well adapted to fire and drought

The genetic diversity of Brutia pine is remarkably high. This is due to a long isolation of many separated populations and to geological and climatic factors. Provenance and laboratory tests have revealed significant geographic patterns in trait variability. The trees are well adapted to drought conditions and fire incidents as they have a thick cuticle and thick epidermal layers. The cones remain closed for a number of years after their maturity and are opened by fire, which at the same time provides good conditions for germination.

Most threats are human induced

New and old hazards are threatening and damaging forests of *Pinus brutia*. Among these threats, the most important are forest fires occurring with unnaturally high frequencies and intensities, grazing, insects and recently air pollution, climate change and urbanization. Global warming and the modification of rainfall regimes especially may modify its distribution range. The processionary caterpillars, *Thaumatopoea pityocampa* and *Thaumatopoea wilkinsonii*, can induce severe defoliation throughout the distribution area although they don't often lead to mortality, unless repeated infestations occur.

The species has high importance for today's forest management and conservation

The exceptional ability of *Pinus brutia* to grow on a wide range of soils, substrates and altitudes, and to withstand extreme climatic conditions, as well as its growth potential, make it one of the most promising pine species for the reforestation programmes in the countries of the Mediterranean basin. Moreover, its closed cone habit and its drought tolerance make it an irreplaceable forest species in the special and delicate Mediterranean ecosystems which suffer from repeated drought events and fires.

ICP Forests monitoring results give detailed information

A number of Level I and Level II plots dominated by *Pinus brutia* have been selected in Cyprus, Greece and Turkey in the framework of the ICP Forests programme.

First results from Cyprus show that drought affects the defoliation of *Pinus brutia* while effects of air pollution on trees have not been observed. Main factors contributing to defoliation are drought events and insects such as *Thaumatopoea wilkinsonii* and *Leucaspis* spp.

Although the ambient levels of ozone in the region of the Level II plots are above threshold values, no adverse effects on the pines and the other vegetation have been observed, even in periods with a severe exceedance of critical limits. This is attributed to the adaptation of the Mediterranean vegetation which keeps the stomata closed during the drought periods, thus preventing the uptake of ozone.

Within the BioSoil demonstration project (Biodiversity module, R2152/03/EC Forest Focus), the ecosystems of *Pinus brutia* in Cyprus show high biodiversity and conservation value. The number of vascular plants in the plots ranges from 10 to 57 and, in most cases a high number of endemic species are included. The extension of the monitoring activities on *Pinus brutia* ecosystems to additional countries, within the framework of ICP Forests, will contribute to the better understanding, conservation and management of these valuable ecosystems.

Intensive Monitoring plot in a central European beech forest with litterfall (white) and deposition (orange) samplers.

3. Sulphur deposition is decreasing, but nitrogen remains high on the agenda

Summary

- *Mean annual sulphur inputs decreased by 25% in the observation period from 2000-2005. These findings result from measurements conducted under the forest canopy on 215 plots located mostly in central Europe. Nitrogen inputs remained rather unchanged.*
- *This shows the success of clean air policies under the UNECE and the EU with respect to sulphur emissions, whereas for nitrogen considerable emission reductions are still needed.*
- *Deposition is mostly higher on plots in central Europe than in the north and south.*

Forests filter the air. They are thus particularly affected by air pollution

Between 2000 and 2005, sulphate in bulk deposition decreased from 6.1 to 4.6 kg per hectare and year. Throughfall sulphate deposition measured below the forest canopy decreased from 7.9 to 5.9 kg. These are mean values from around 200 measurement stations mainly located in central Europe. On 23% of the plots inputs decreased whereas there were hardly any plots with increasing deposition. Throughfall deposition is on average higher than bulk deposition as trees filter parts of the dry deposition from the air. Highest sulphate inputs were found on sites in central Europe and in the east of the investigated Mediterranean region (see Figs. 3-1 to 3-3). Sulphate inputs on plots near the coasts can, however, be of natural maritime origin. Decreasing inputs show the success of clean air policies under the UNECE and the EU with respect to sulphur emissions, whereas for nitrogen considerable emission reductions are needed.

There are hardly any changes in mean nitrogen deposition

Mean deposition of throughfall and bulk nitrate deposition fluctuated over the years 2000–2005 and there were hardly any plots with significant changes in nitrate throughfall deposition. The same holds true for atmospheric ammonium inputs. Highest nitrate and ammonium deposition occurred on plots in central Europe from the north of Italy to southern Scandinavia (see Figs. 3-4 to 3-9). The high variability of forest and site types across Europe underlines the necessity of a broad monitoring approach.

Element fluxes and their assessment

ICP Forests started to implement deposition measurements on intensive monitoring plots in the second half of the 1990s. Measurements are carried out within the forest stands (throughfall deposition) and in nearby open fields (bulk deposition). In the forest canopy, some elements can be leached from the foliage and increase the measured deposition load, whereas others are taken up by leaves and needles and are thus not detected in throughfall. Bulk deposition is not influenced by element fluxes in the canopy but is mostly lower than throughfall because the forest canopy filters additional deposition loads from the air. Thus, neither throughfall nor bulk deposition is equal to the total deposition that is received by the forest stands. In this chapter, throughfall deposition is presented as it reflects the inputs that reach the forest floor and is thus of higher ecological relevance for the forest ecosystems as compared to the open field measurements. On the plots, samples are collected weekly, fortnightly or monthly and are analysed by national experts. After intensive quality checks, annual mean deposition for the years 2000 to 2005 was calculated for plots with complete data sets. Slopes of plotwise linear regressions of deposition over time were tested for significance. Plot specific means were calculated for the period 2003 to 2005.

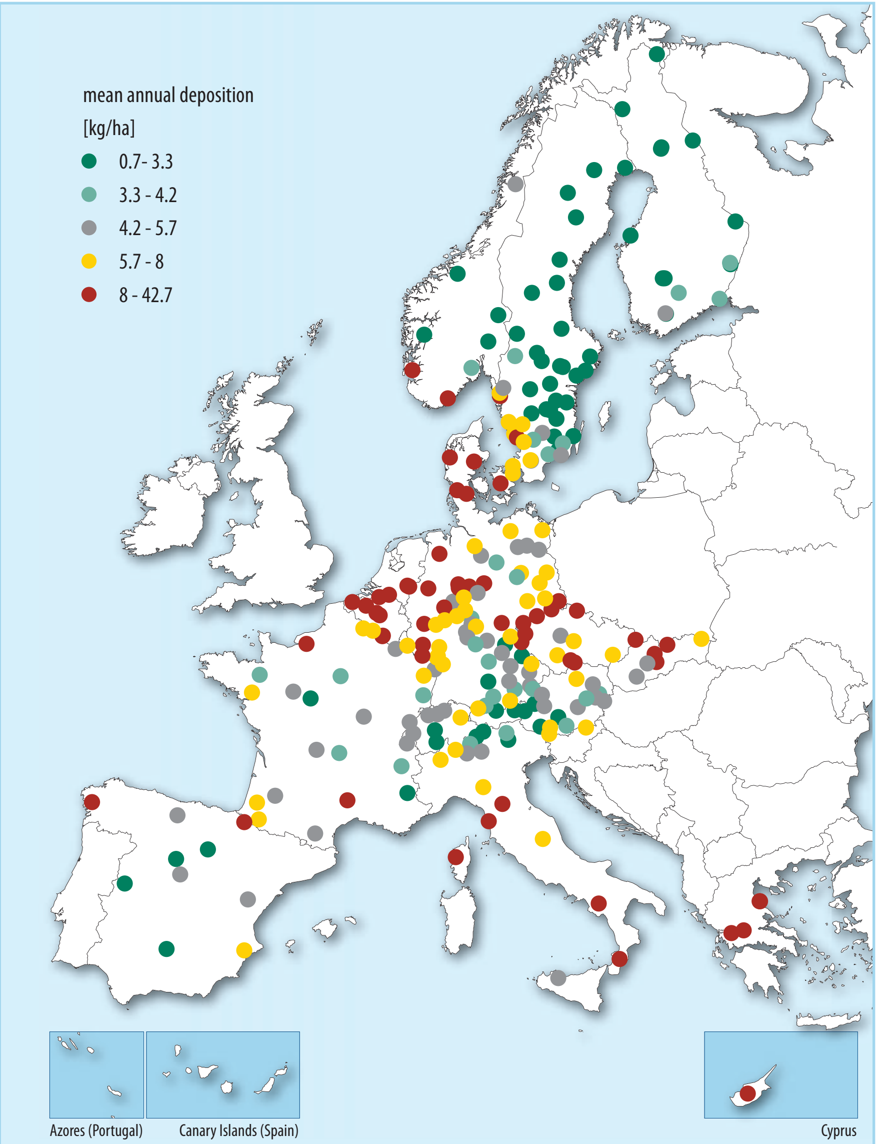

Figure 3-1: Mean sulphate (SO_4-S) throughfall deposition, 2003-2005 on 249 plots (depending on annual precipitation amount).

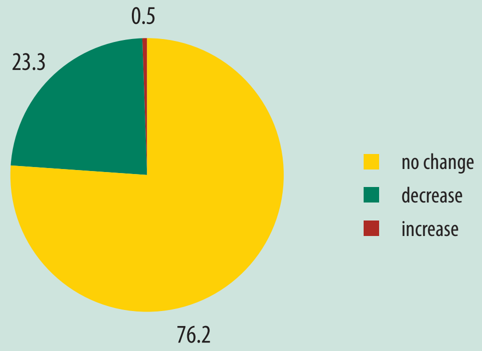

Figure 3-2: Percentage of plots with decreasing or increasing sulphate deposition, 2000-2005, 215 plots.

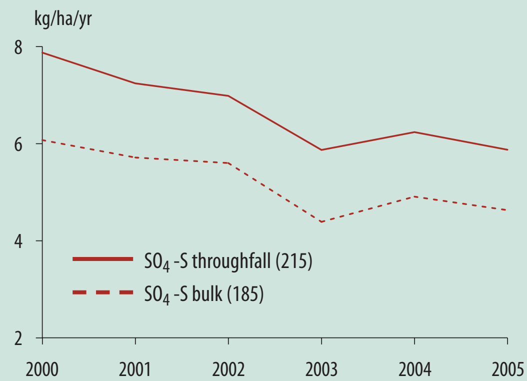

Figure 3-3: Development of mean sulphate deposition (plot numbers in brackets).

Critical loads are an important tool to assess deposition effects on forest ecosystems

The mere size of sulphur and nitrogen inputs does not give information on the impacts of the pollutants on the ecosystems. Such effects depend on the specific site and stand conditions on the monitoring sites. Critical loads have been calculated by ICP Forests to evaluate effects of atmospheric deposition on forests. Last years' reports showed that atmospheric acidity deposition is above critical loads on around one fourth of the investigated plots. Critical loads for nutrient nitrogen were exceeded on two thirds of the plots. In view of the still high nitrate and ammonium inputs, the implementation of the UNECE Protocol to Abate Acidification, Eutrophication and Ground-level Ozone that entered into force on 17 May 2005 remains high on the political agenda.

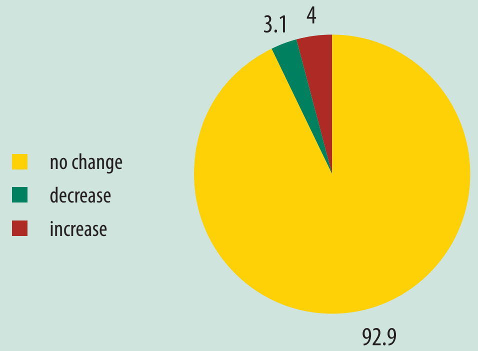

Figure 3-4 Percentage of plots with decreasing or increasing nitrate deposition, 2000-2005, 223 plots.

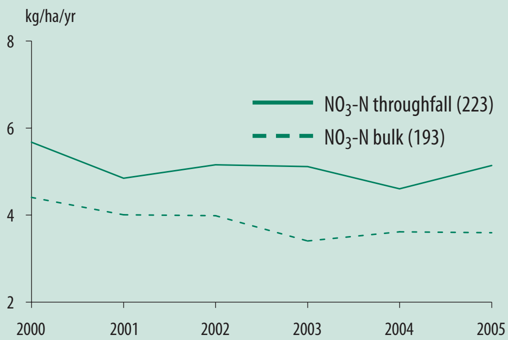

Figure 3-5: Development of mean nitrate deposition (plot numbers in brackets).

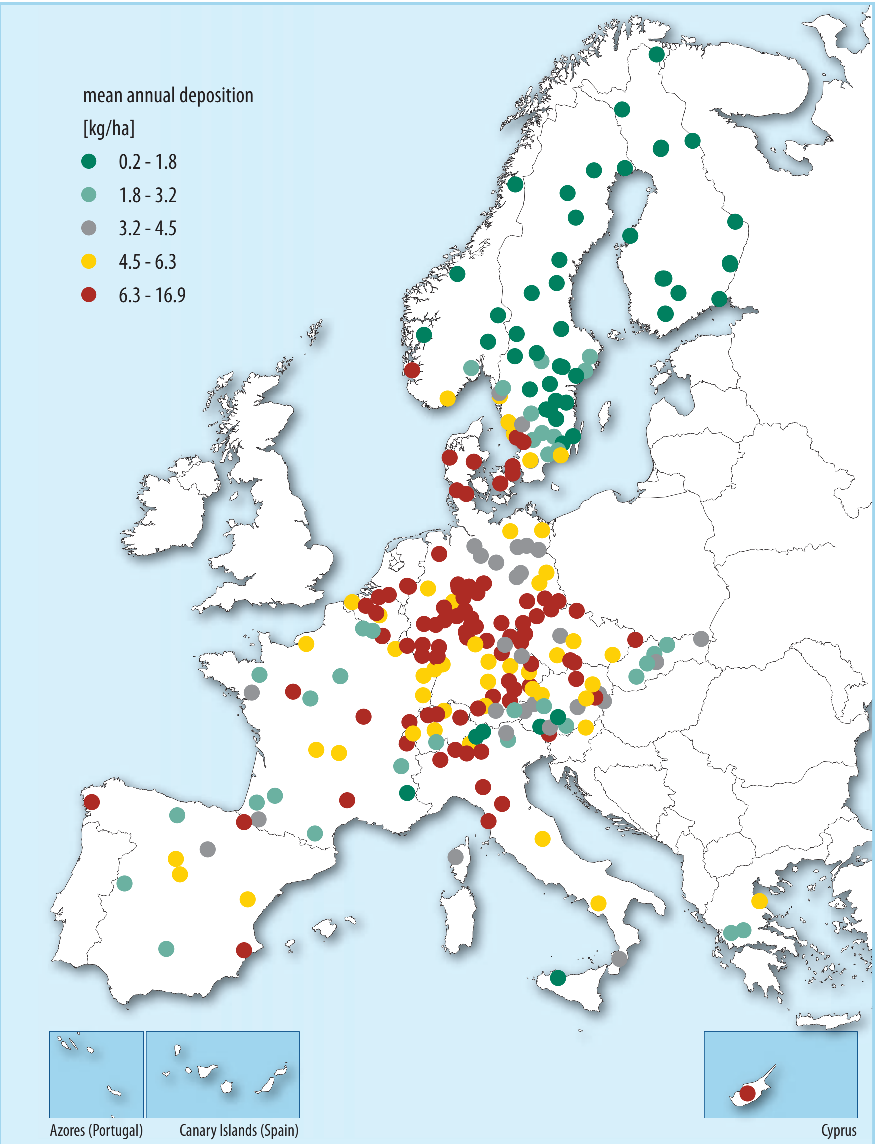

Figure 3-6: Mean nitrate (NO_3-N) throughfall deposition, 2003-2005 on 249 plots (depending on annual precipitation amount).

Deposition endangers the water filtering function of forest soils. In forest stands that receive high atmoshperic nitrogen inputs and that are already nitrogen saturated, nitrate is leached into ground and surface waters.

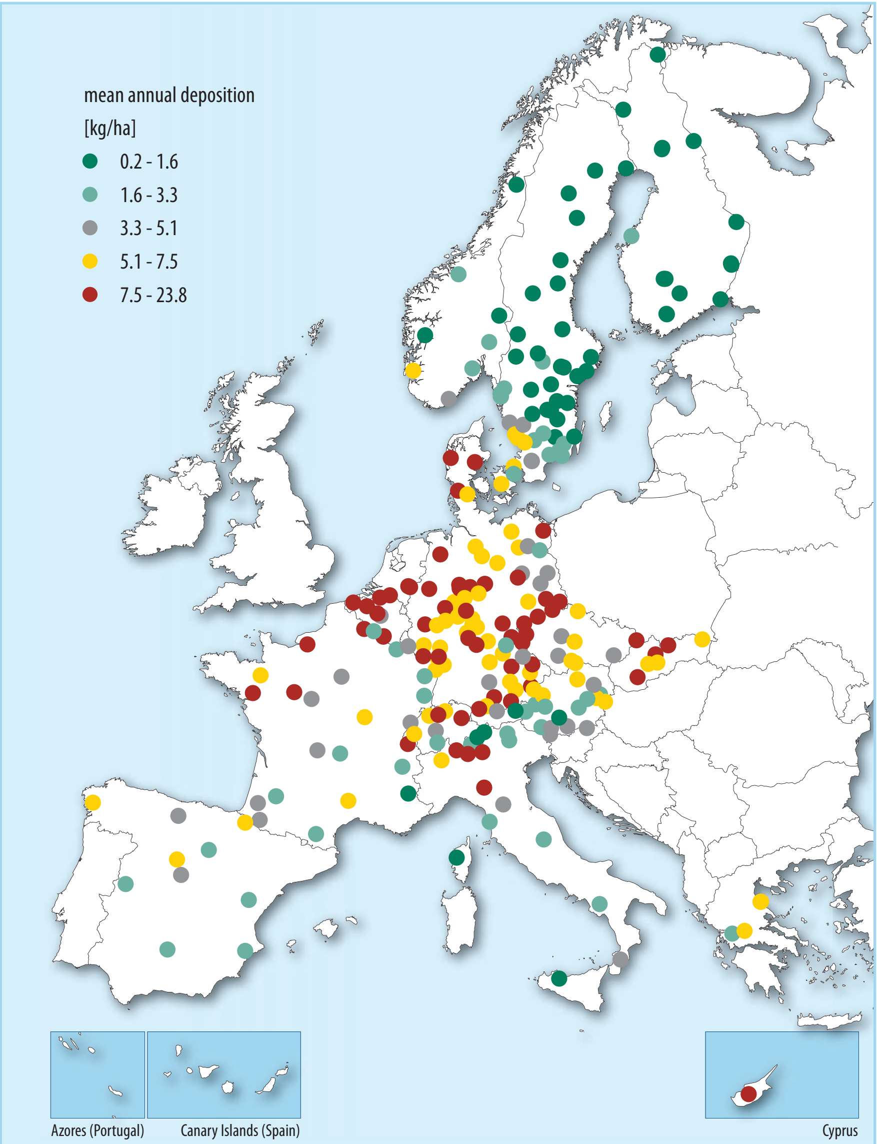

Figure 3-7: Mean ammonium (NH_4-N) throughfall deposition, 2003-2005 on 249 plots (depending on annual precipitation amount).

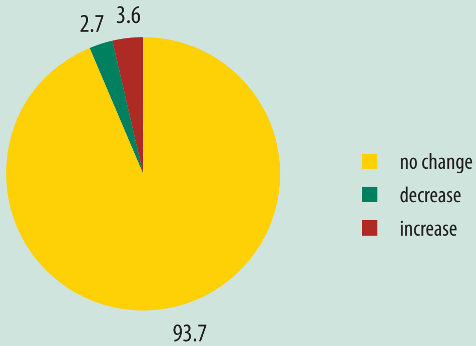

Figure 3-8: Percentage of plots with decreasing or increasing ammonium deposition, 2000-2005, 222 plots.

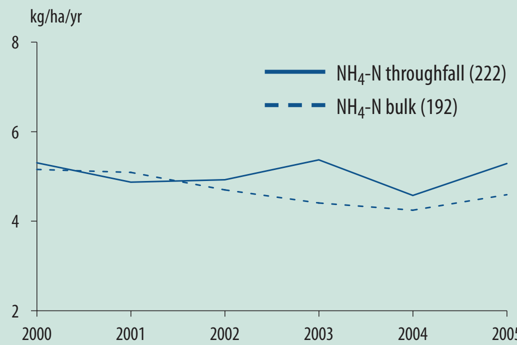

Figure 3-9: Development of mean ammonium deposition (plot numbers in brackets).

4. Conclusions

A unique forest monitoring system is being implemented in 41 countries

For more than 20 years forest condition has been monitored by ICP Forests under the Convention on Long-range Transboundary Air Pollution (CLRTAP) and the European Commission. Today the programme is one of the largest forest monitoring networks in the world. The system combines an inventory approach with intensive monitoring. It provides quality assured and representative data on forest ecosystem health and vitality and helps to detect responses of forest ecosystems to the changing environment. ICP Forests contributes by means of its monitoring activities to other aspects of relevance for forest policy at national, pan-European and global levels, such as effects of air pollution and climate change on forests, sustainable forest management and biodiversity in forests. To date the data collected provide a major input for several international programmes and initiatives, such as CLRTAP and the Ministerial Conference for the Protection of Forests in Europe (MCPFE). In addition, the long time series are available for scientific studies.

Two monitoring approaches are implemented to provide an insight into forest ecosystem health and vitality

ICP Forests uses two complementary monitoring approaches on the European level. Representative monitoring (Level I) is based on around 6 000 plots and provides an annual overview of forest condition on the European level. Intensive monitoring (Level II) on around 800 sites provides insight into factors affecting the condition of forest ecosystems and into the effects and interactions of different stress factors.

The programme provides an early warning system for the impact of environmental stress factors on forest ecosystem health and vitality

In the early 1980s a dramatic deterioration of forest condition was observed in Europe and resulted in the implementation of forest condition monitoring under CLRTAP. The annual assessment of forest condition allows for a holistic picture of the current state and changes in space and time. Results show effects of air pollution on tree crown condition, interacting with other stress factors like insects, fungi and extreme weather events. The drought in the Mediterranean region in the mid 1990s and the extremely warm and dry summer across large parts of Europe in 2003 led to

Birch stand, Estonia.

increased defoliation as a natural reaction of trees to this kind of stress. The long time series provided by the programme are unique and facilitate the analysis of the interaction of air pollution and climate change effects on forest ecosystems. Although forest species have responded to environmental changes throughout their evolutionary history, a primary concern for wild species and their ecosystems is the rapid rate of human induced changes.

Crown defoliation, an indicator for tree vitality, is still of concern

After peaks in mean defoliation in the mid 1990s and again in 2004/05 there was a recuperation in crown condition in the last two years. Around 20% of more than 100 000 assessed trees were classified as damaged in 2007. Of the main tree species European and sessile oak showed the highest defoliation.

Nitrogen inputs remain a major factor in the change of forest condition

Sulphate inputs decreased on 23% of 215 intensive monitoring plots but still constitute a major influence on forest soils. Nutrient nitrogen inputs remained unchanged on over 90% of the sites. These results reflect successful clean air policies in the last decades, but further emission reductions are needed, specifically related to nitrogen. This is shown by the fact that critical loads for atmospheric acidity deposition are exceeded on around a fourth of the investigated plots, while critical loads for nutrient nitrogen are exceeded on two thirds of the plots.

Ecological effects of the continuing high nitrogen inputs include shifts in species composition of ground vegetation, destabilisation of forest ecosystems and risks for drinking water quality. On sites that are not yet nitrogen saturated, the inputs can increase forest growth. However, with an increasing nitrogen saturation of many forest ecosystems the need for reduced emission will become greater in the future. During the period 2000 to 2004, critical levels of ozone for sensitive forest species were frequently exceeded.

Cooperation remains important for the future understanding of forest ecosystem health and vitality

The long cooperation of ICP Forests and the European Commission has enabled the implementation of a harmonized and operational monitoring system. Most countries of the pan-European region participate in the programme. Contributions have been made to the UN-FAO/ECE Forest Resources Assessment, the Convention on Biological Diversity, the MCPFE report "Forests in Europe 2007" and to other international initiatives and programmes.

The programme's success is evident from the strong national commitments, the engagement and commitment of national experts and their active involvement in Expert Panels and Working Groups, and the exemplary collaboration of the ICP Forests Programme Coordinating Centre and the European Commission services.

It is widely accepted that ICP Forests' monitoring programme is the backbone for describing and understanding the impacts of environmental changes on forest ecosystems in Europe. New challenges arising from air pollution, biodiversity loss and climate change effects on forests require joint efforts to refine the programme for future needs and contribute to the maintenance and enhancement of the sustainable provision of goods and services by forests.

Annex I: Forests and surveys and defoliation classes for all species in European countries (2007)

– Results of national surveys as submitted by National Focal Centres –

Participating countries	Forest area (x 1000 ha)	% forest area	Grid size (km x km)	No. of sample plots	No. of sample trees	0 none	1 slight	2+3+4
Albania	1063	37.0				No survey in 2007		
Andorra	18		16 x 16	3	72	15.3	37.5	47.2
Austria	3878	46.2				No survey in 2007		
Belarus	7812	37.8	16 x 16	400	9425	34.0	57.9	8.1
Belgium	691	22.8	4^2 / 8^2	121	2863	34.5	49.1	16.4
Bulgaria	4064	29.9	$4^2/8^2/16^2$	145	4926	20.5	49.9	29.7
Croatia	2061	36.5	16 x 16	84	2012	37.2	37.7	25.1
Cyprus	298	32.2	16x16	15	360	10.3	73.0	16.7
Czech Republic	2647	33.6	$8^2/16^2$	132	5489	12.2	30.7	57.1
Denmark	486	11.3	$7^2/16^2$	19	442	67.4	26.5	6.1
Estonia	2252	49.9	16 x 16	93	2209	50.1	43.1	6.8
Finland	20149	66.3	16^2 / 24x32	593	11199	52.1	37.4	10.5
France	15840	28.9	16 x 16	504	10073	29.0	35.6	35.4
Germany	11076	28.9	16^2 / 4^2	420	10241	30.0	45.2	24.8
Greece	2512	19.5				No survey in 2007		
Hungary	1869	20.1	4 x 4	78	1872	51.8	27.5	20.7
Ireland	680	6.3	16 x 16	34	772	76.3	17.5	6.2
Italy	8675	28.8	16 x 16	238	6636	24.0	40.3	35.7
Latvia	2958	45.8	8 x 8	349	8278	20.0	65.0	15.0
Liechtenstein	8	50.0				No survey in 2007		
Lithuania	2136	32.7	8x8/16x16	271	6538	20.2	67.5	12.3
Luxembourg	89	34.4				No survey in 2007		
Republic of Moldova	318	9.4	2x2/2x4	528	14176	36.1	31.4	32.5
The Netherlands	334	9.6				No survey in 2007		
Norway	12000	37.1	$3^2/9^2$	1658	9161	37.4	36.4	26.2
Poland	9200	29.4	16 x 16	458	9160	23.8	56.1	20.2
Portugal	3234	36.4				No survey in 2007		
Romania	6233	26.1	16 x 16	218	5232	34.7	42.1	23.2
Russian Fed.	8125	73.2				No survey in 2007		
Serbia	2360		16 x 16/4 x 4	130	2860	55.2	29.4	15.4
Slovak Republic	1961	40.0	16 x 16	107	4023	12.6	61.8	25.6
Slovenia	1099	54.2	16 x 16	45	1056	22.3	42.0	35.8
Spain	11588	30.9	16 x 16	620	14880	18.0	64.3	17.6
Sweden	23400	57.1	Variable	3554	7208	52.6	29.5	17.9
Switzerland	1186	28.7	16 x 16	48	1028	27.8	49.8	22.4
Turkey	21189	27.2	16 x 16	48	949	58.0	33.8	8.2
Ukraine	9400	15.4	16 x 16	1551	36596	68.6	24.3	7.1
United Kingdom	2837	11.7	Random	156	3744	26.5	47.5	26.0
Total	205726		Variable	12601	193442			

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.

Annex II: Defoliation of all species (1996-2007)

- Results of national surveys as submitted by National Focal Centres -

Participating countries	All species, defoliation classes 2-4												Change % points
	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2006/2007
Albania			9.8	9.9	10.1	10.2	13.1		12.2		11.1		
Andorra									36.1		23.0	47.2	-24.2*
Austria	7.9	7.1	6.7	6.8	8.9	9.7	10.2	11.1	13.1	14.8	15.0		
Belarus	39.7	36.3	30.5	26.0	24.0	20.7	9.5	11.3	10.0	9.0	7.9	8.1	0.2
Belgium	21.2	17.4	17.0	17.7	19.0	17.9	17.8	17.3	19.4	19.9	17.9	16.4	-1.5
Bulgaria	39.2	49.6	60.2	44.2	46.3	33.8	37.1	33.7	39.7	35.0	37.4	29.7	-7.7
Croatia	30.1	33.1	25.6	23.1	23.4	25.0	20.6	22.0	25.2	27.1	24.9	25.1	0.2
Cyprus						8.9	2.8	18.4	12.2	10.8	20.8	16.7	-4.1
Czech Rep.	71.9	68.6	48.8	50.4	51.7	52.1	53.4	54.4	57.3	57.1	56.2	57.1	0.9
Denmark	28.0	20.7	22.0	13.2	11.0	7.4	8.7	10.2	11.8	9.4	7.6	6.1	-1.5
Estonia	14.2	11.2	8.7	8.7	7.4	8.5	7.6	7.6	5.3	5.4	6.2	6.8	0.6
Finland	13.2	12.2	11.8	11.4	11.6	11.0	11.5	10.7	9.8	8.8	9.7	10.5	0.8
France	17.8	25.2	23.3	19.7	18.3	20.3	21.9	28.4	31.7	34.2	35.6	35.4	-0.2
Germany	20.3	19.8	21.0	21.7	23.0	21.9	21.4	22.5	31.4	28.5	27.9	24.8	-3.1
Greece	23.9	23.7	21.7	16.6	18.2	21.7	20.9			16.3			
Hungary	19.2	19.4	19.0	18.2	20.8	21.2	21.2	22.5	21.5	21.0	19.2	20.7	**
Ireland	13.0	13.6	16.1	13.0	14.6	17.4	20.7	13.9	17.4	16.2	7.4	6.0	-1.4
Italy	29.9	35.8	35.9	35.3	34.4	38.4	37.3	37.6	35.9	32.9	30.5	35.7	5.2
Latvia	21.2	19.2	16.6	18.9	20.7	15.6	13.8	12.5	12.5	13.1	13.4	15.0	1.6
Liechtenstein													
Lithuania	12.6	14.5	15.7	11.6	13.9	11.7	12.8	14.7	13.9	11.0	12.0	12.3	0.3
Luxembourg	37.5	29.9	25.3	19.2	23.4								
Rep. of Moldova	41.2				29.1	36.9	42.5	42.4	34.0	26.5	27.6	32.5	4.9
The Netherlands	34.1	34.6	31.0	12.9	21.8	19.9	21.7	18.0	27.5	30.2	19.5		
Norway	29.4	30.7	30.6	28.6	24.3	27.2	25.5	22.9	20.7	21.6	23.3	26.2	2.9
Poland	39.7	36.6	34.6	30.6	32.0	30.6	32.7	34.7	34.6	30.7	20.1	20.2	0.1
Portugal	7.3	8.3	10.2	11.1	10.3	10.1	9.6	13.0	16.6	24.3			
Romania	16.9	15.6	12.3	12.7	14.3	13.3	13.5	12.6	11.7	8.1	8.6	23.2	**
Russian Fed.						9.8	10.9						
Serbia	3.6	7.7	8.4	11.2	8.4	14.0	3.9	22.8	14.3	16.4	11.3	15.4	4.1
Slovak Rep.	34.0	31.0	32.5	27.8	23.5	31.7	24.8	31.4	26.7	22.9	28.1	25.6	-2.5
Slovenia	19.0	25.7	27.6	29.1	24.8	28.9	28.1	27.5	29.3	30.6	29.4	35.8	6.4
Spain	19.4	13.7	13.6	12.9	13.8	13.0	16.4	16.6	15.0	21.3	21.5	17.6	-3.9
Sweden	17.4	14.9	14.2	13.2	13.7	17.5	16.8	19.2	16.5	18.4	19.4	17.9	**
Switzerland	20.8	16.9	19.1	19.0	29.4	18.2	18.6	14.9	29.1	28.1	22.6	22.4	-0.2
Turkey												8.2	
Ukraine	46.0	31.4	51.5	56.2	60.7	39.6	27.7	27.0	29.9	8.7	6.6	7.1	0.5
United Kingdom	14.3	19.0	21.1	21.4	21.6	21.1	27.3	24.7	26.5	24.8	25.9	26.0	**

Austria: From 2003 on, results are based on the 16x16 km transnational grid net and must not be compared with previous years. *Czech Republic:* Only trees older than 60 years assessed until 1997. *France:* Due to methodological changes, only the time series 1997-2007 is consistent. *Italy:* Due to methodological changes, only the time series 1993-96 and 1997-2007 are consistent, but these are not comparable to each other. *Russian Federation:* North-western and central European parts only. *Ukraine:* Due to a denser gridnet since 2005, results must not be compared with previous years. * Observe the small sample size. ** Comparison not possible due to changing survey design.

Note that some differences in the level of damage across national borders may be at least partly due to differences in standards used. This restriction, however, does not affect the reliability of the trends over time.

Annex III: Numbers of Intensive Monitoring Plots with data submission in 2006

	All*	Crown Condition	Soil	Soil Solution	Foliage	Growth	Deposition	Meteorology	Ground vegetation	Phenology	Air quality	Ozone injury	Litterfall
Andorra													
Austria	20	19		2	20		20	2	20				
BE : Flanders	12	7		5			5	1		1		1	5
BE : Wallonia	9	8		2				4					
Belarus													
Bulgaria	3	3				3	3	3	3		3		3
Croatia													
Cyprus	4	4		2			2	2			2		
Czech Republic	21	16		11			12	10	4				
Denmark	22	8		8			8	1					7
Estonia	8	8		5			7	1	7				
Finland	33	31		17			17	10					
France	100	94		14			25	25		83	25		90
Germany	95	87		76	37	8	88	83	40		37		19
Greece	4	4		1			4	4					2
Hungary	15	15		1			15	12		15		9	
Ireland	16			3			3	3					
Italy	31	30		8			30	22	24	25	30	4	
Latvia	3	1		1			1						
Lithuania	9	9		2			2		9		2	8	2
Luxembourg	2	2					1	2		2	2		2
Netherlands	14	5		3			5						
Norway	19	8		8			8						
Poland	150	86		1			86						
Portugal	13	7					1						
Republic of Moldova													
Romania	13	12		4		12	4		12	2			2
Russia	12												
Serbia													
Slovak Republic	9			3			7						
Slovenia	11	11		2			5	11		11			
Spain	61	54		3		54	13	13		13	13	13	13
Sweden	100	95		43	93		43	10					
Switzerland	18	18		7			12	16			7	7	
Turkey	8												
United Kingdom	20	20		9			10						
Total	855	662	0	241	150	77	437	235	119	152	121	42	145

Annex IV: Photo references

D. Aamlid: p.8, A. Christou: pp. 7, 12, 13; R. Fischer: pp. 14, 19; Ministry of Agriculture, Natural Resources and Environment, Cyprus: p.6; V. Mues: p. 10; J. Wernecke p. 17.

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