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GENERAL DIRECTORATE OF FORESTRY

Department of Fighting Against Forest Pests

Health State of Forests in Turkey (2008 - 2012)

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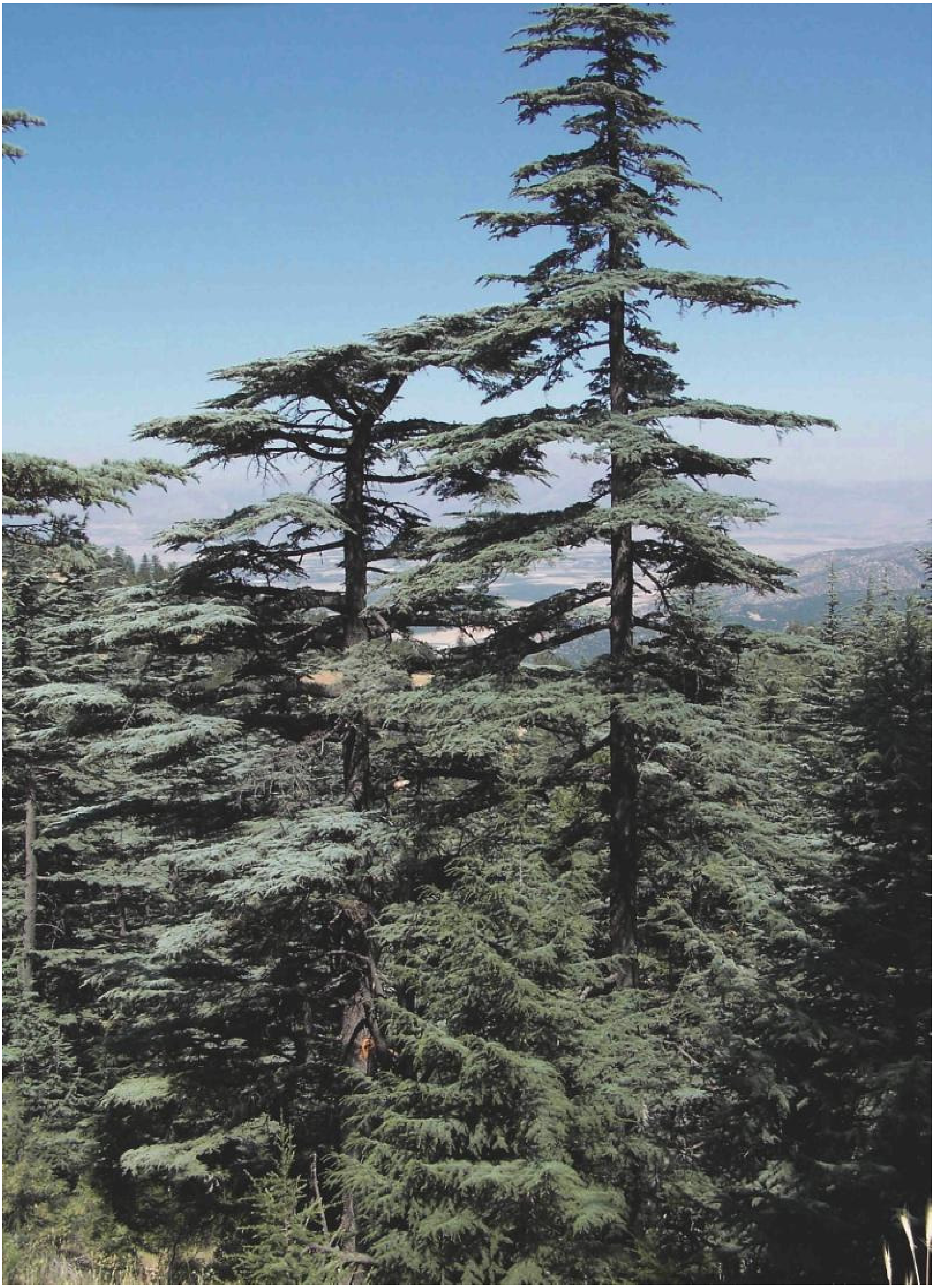


INTRODUCTION

International Cooperation Program on the Monitoring and Evaluation of Effects of Air Pollution on Forests established in 1985 under the “United Nations Economic Commission for Europe - Convention on Long-Range Transboundary Air Pollution” has been continued since 1986 in 41 countries, at 6000 level I and at 700 level II observation sites.

One-third of Europe is covered by forests while forests constitute 27.6 % of the surface area of our country. However, being a bridge among three continents, Turkey possesses rich ecological regions under the influence of diverse climatic and edaphic factors and a variety of forest ecosystems and habitats in these regions, with the result that it has the richest biodiversity in Europe and the Near East regions.

Thanks to her being a host for rich diversity of flora and fauna, the international importance of her forest ecosystems and her active participation in international cooperation programs, our country is expected to make more scientific contributions to such processes as the Convention on Biological Diversity, the Framework Convention on Climate Change, and the Europe Ministerial Conference on the Protection of Forests.

Despite the fact that forest ecosystems constitute the most important part of our natural resources, they are often intertwined with other ecosystems, and for this very reason, it is required to ensure a sustainable management of these ecosystems which interact with each other. Therefore, it will be easier also to take strategic decisions in the sustainable management of natural resources when the data and the information obtained with the monitoring programs for forest ecosystems are linked with the environmental information of the other ecosystems.

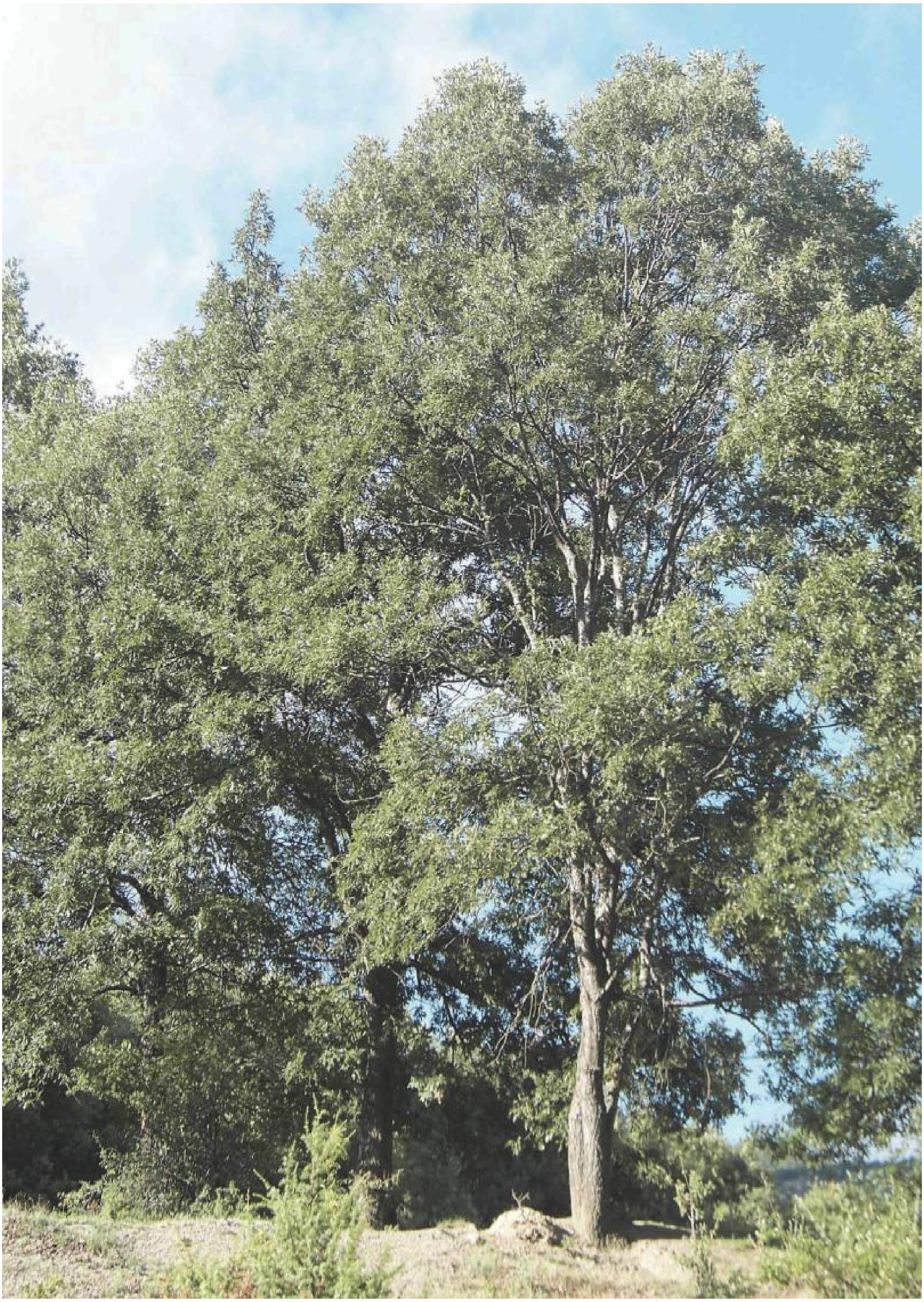
In addition, our efficiency in international data exchange will further increase when the reporting and graphical presentations over Geographic Information Systems facilities and databases are made to be healthy and up-to-date according to European Union standards. These studies will improve, in the future, the effectiveness and co-operation of our country in and before the European Economic Commission of the United Nations and the European Commission of European Union.

For this purpose, Level I and Level II programs have been initiated by establishing fixed observation areas in the forestry areas under the responsibility of General Directorate of Forestry (GDF), and thus, the studies involving the monitoring of our country’s forest ecosystems and the reporting the state of these ecosystems over the database to be created have been continued since 2006.

This report covers the 5-year implementation results of our country's forest ecosystem monitoring program between the years 2008-2012, which was carried out with the contributions of Our Ministry, Universities and Non-Governmental Organizations and in cooperation with international organizations. I sincerely hope that this report will provide significant contributions to our forestry and to the healthier planning of our forests.

I would like to thank to those who have contributed in the preparation of this report and I wish them all the successes in their work.

Prof. Dr. Veysel EROGLU
Minister of Forestry and Water Affairs



PREAMBLE

Forests provide us with various valuable benefits such as forest products production, water production, erosion prevention, climate regulation (including oxygen production and carbon sequestration), public health, environmental protection, aesthetics, recreation, national defense and scientific functions. Apart from these benefits they provide to people, forests also host many plants and animals.

Due to the services they provide and their hosting to the plants and animals, which are indispensable elements of the natural world, it is very important principally to preserve forests and to pass them over the future generations.

It is required to monitor and manage the forests in a sustainable way as they are adversely affected from climate changes and air pollution.

The forest ecosystem monitoring program started in 1986 and implemented by the United Nations Economic Commission for Europe and by the European Union was participated by 41 countries (39 European countries with the U.S. and Canada) including Turkey in 2012; this was an important development for the world forestry. Our country's involvement in this program and implanting it in an integrated manner with the world represents an important point for us and for out forestry.

Monitoring the health of forest ecosystems is among the indispensable criteria of sustainable forest management, which ranks first among the essential criteria. The health of forests, which host several living creatures, is important, and this makes it necessary to monitor forests based on certain criteria. In this context, it is our first priority to ensure that our organization renews itself, follows developments and pay due importance to research studies.

The forest ecosystem monitoring program, which was started as a project in 2006 and today, is now carried out by observations and sampling studies on several subjects based on fixed observation sites across the country. It is vital for our country's forestry that this program, today in its fifth year, should be continued without fail.

Based on the data obtained during first five years' implementation, this report will undoubtedly contribute to us in setting up strategies for future. Such reports are not only necessary for planning the future, but also will guide us in our works.

I wish to thank all those who have contributed in the preparation of this report, and I urge that this program, with the top priority in the sustainable forest management criteria, should be executed without interruption.

Ibrahim CIFTCI
General Manager

TABLE OF CONTENTS

Oriental Spruce forest (*Picea orientalis*) (Macka, Trabzon)

1. INTRODUCTION

Ecological problems such as global warming and climate change, desertification, reduction in biodiversity, and air, water and soil pollutions are the most vital problems facing humanity and the nature today. At the very core of such ecological problems lies the attitude of people to benefit from the nature excessively and without paying due care to the ecological processes. These ecological problems even threatens the ecosystems that have not lost their natural status. Forests are at the very top of these ecosystems. Forests provide several beneficial services to humanity such as supply of forest products, water production, erosion prevention, climate regulation (including oxygen production and carbon sequestration), public health, environmental protection, aesthetics, recreation, national defense and scientific functions. Besides these benefits, forests also act as a host for many plants and animals. Therefore, conservation of forests constitutes the center of nature protection as well.

On the other hand, with respect to prevention of global warming and climate change, which are the most important ecological issues of recent years, forests act as a carbon pool, further increasing the importance of forests. However, it is also a fact that health of forests can be disrupted by the impact of a variety of ecological problems.

Indeed, during the 1970s, some deterioration was observed in the health status of forests, first in Fir (Abies alba) forests in Central Europe and then in other coniferous species, and also in other European countries.

Called as the new type of forest damages, these health problems appear in the form of discoloration of the leaves of forest trees, premature fall of leaves, changes in the leave shapes, and increment losses, resulting with forest mass mortality in some places. Air pollution was suspected to have impacts on these damages and forest mass mortality, and researches have focused on air pollution. However; these researches on the types of these new forest damages, which emerged in approximately the same times in many countries and in the same tree species, have been conducted by different methods and a comparison between their results have not been possible.

Moreover, the understanding that several other factors (drought, nutrient deficiency, unfavorable habitat conditions, insects and fungi, etc.) along with air pollution are also effective in forest diseases, and the observation that health states of forests have changed by time required the use of novel techniques.

Because, in most survey and inventory studies made in the past, the sampling sites would not be studied again after the measurements in the sampling sites had been completed, and thus the changes occurring in ecosystems by time would not be determined.

For this purpose, the United Nations Economic Commission for Europe (UNECE) decided in 1985 to establish the "International Cooperation Program for Monitoring and Evaluation of the Effects of Air Pollution on Forest", in accordance with Convention on Long-Range Transboundary Air Pollution (CLRTAP).

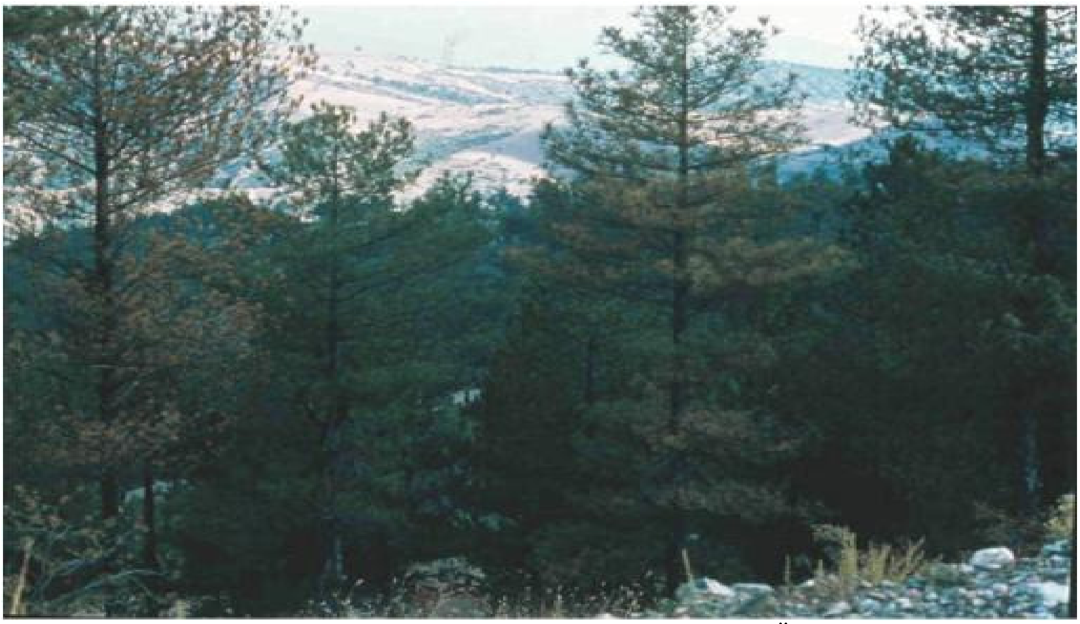
Known briefly as International Cooperation Program Forests (ICP Forests), this program aims to gather detailed and comparable data on the changes in the forests at the national level, associated with current ecological conditions (mostly air pollution, including acid storage), and thus, to better understand the damage caused by pollution and the cause-and- effect relationships.

The forest ecosystem monitoring program started in 1986 and implemented by the United Nations Economic Commission for Europe and by the European Union was participated by 41 countries (39 European countries with the U.S. and Canada) including Turkey in 2012; this was an important development for the world forestry. Our country's involvement in this program and implanting it in an integrated manner with the world represents an important point for us and for out forestry. Started to be implemented in 1986 and carried out by the United Nations Economic Commission for Europe and by the European Union, the program was contributed 41 countries, including Turkey (39 European countries with the U.S. and Canada) as of the year 2012.

International Cooperation Program Forests ("ICP Forests") provides a scientific basis related with the effects of air pollution and other environmental factors, to the Implementation Body of Convention on Long-Range Transboundary Air Pollution. International Forestry Cooperation Program, together with the other programs under the contract assists to the Implementation Body to develop legally binding protocols on the international air pollution reduction policies, by conducting studies on the impacts of air pollution on ecosystems, vegetation, fresh waters, cultural heritage and material as well as on human health (Lorenz, 2010).

Within the scope of the studies made under International Cooperation Program Forests, which completed its 25th year in 2011, information is produced related not only with clean air policies but also with forest health, biodiversity, sustainable forest management and climate changes.

The first step for the studies on the monitoring of forest ecosystems in Turkey was taken in 2006. The first two years of the monitoring activities was pent on the establishing sampling sites and on training, and studies were carried out in 2007 in a few observation sites. Since 2008, data was started to be taken from a large number of observation sites. This present study aims to provide an introduction to Forest Ecosystems Monitoring Program and to present the results obtained for the 5 years' period between 2008-2012.



Trees damaged by air pollution in Yatagan (Photo: M.Ö.Karaöz)

A Level II Observation Site in Germany

2. METHODOLOGY IN THE MONITORING OF FOREST ECOSYSTEMS

Monitoring studies for the forests under International Cooperation Program Forests (ICP Forests) are carried out in two methods, called as extensive and intensive monitoring. Of these, extensive monitoring studies are called as Level I and intensive monitoring studies are called Level II studies.

Level I studies are implemented at lower monitoring intensity on the network grid that is identified and systematically selected by the European Union. This network grid is arranged as a 16x16 km plot throughout Europe. Each country is capable of setting up a monitoring system at different intensities depending on its own ecological conditions and on the structure of its forests. For the establishment of the Level I observation sites, which are of fixed example sites, first the intersection points of the network grid are determined, then 25 m towards each of the north, south, east, west directions is traveled and the locations (satellite) of sub-observation sites where the monitoring studies are to be carried out are determined. (Figures 1 and 2).

A total of 24 sample trees are selected and are numbered, 6 each being taken from the individuals closest to the centers of these satellites, which are located in the dominant layers (According to Kraft, 1 = pre-dominant, 2 = dominant, 3 = co-dominant trees; Figure 3). Crown assessment is made in these selected trees every year. Some of the parameters to be assesses in the said plot are compulsory while others are left for option. The basic parameters for the assessment of the crown condition are leaf / needle loss, leaf / needle discoloration, and determination of damage factors (Figure 4). Studies to determine the loss of leaves / needles in the Level I observation sites act as an early warning system indicating whether forests have been affected by various stress factors.

In addition, samples of leaves / needles and soil are also taken at certain periods in Level I, which is a low intensity monitoring system.

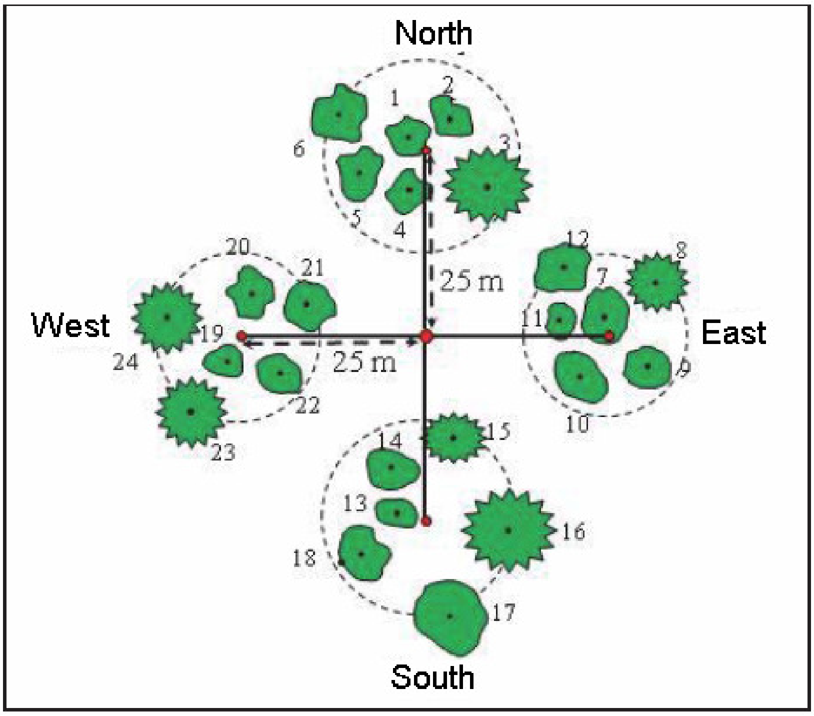


Figure 1. Sampling pattern used in Level I observation sites in the forest monitoring program in European (from UN/ECE, 2004, amended).

Figure 2. Photographs of the center and satellites of Level I observation site with No. 1447 (Photo: Ankara Regional Directorate of Forestry)

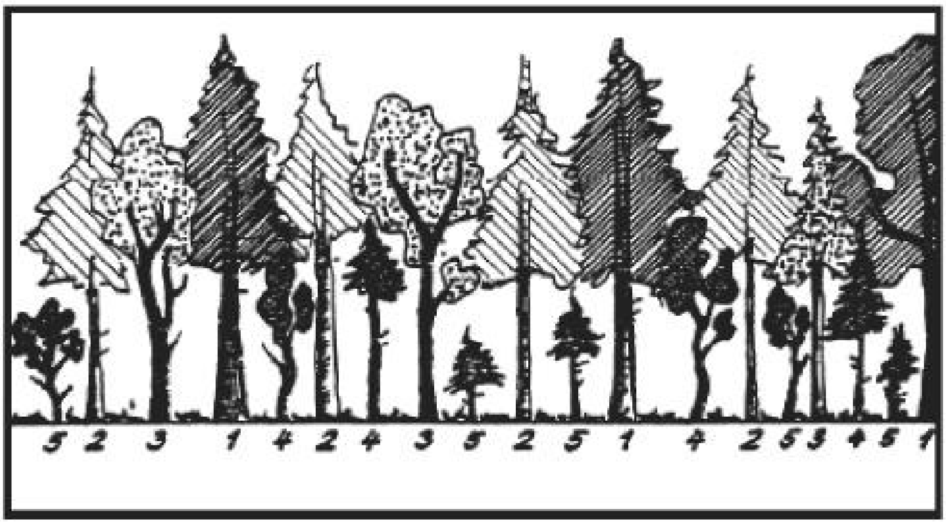
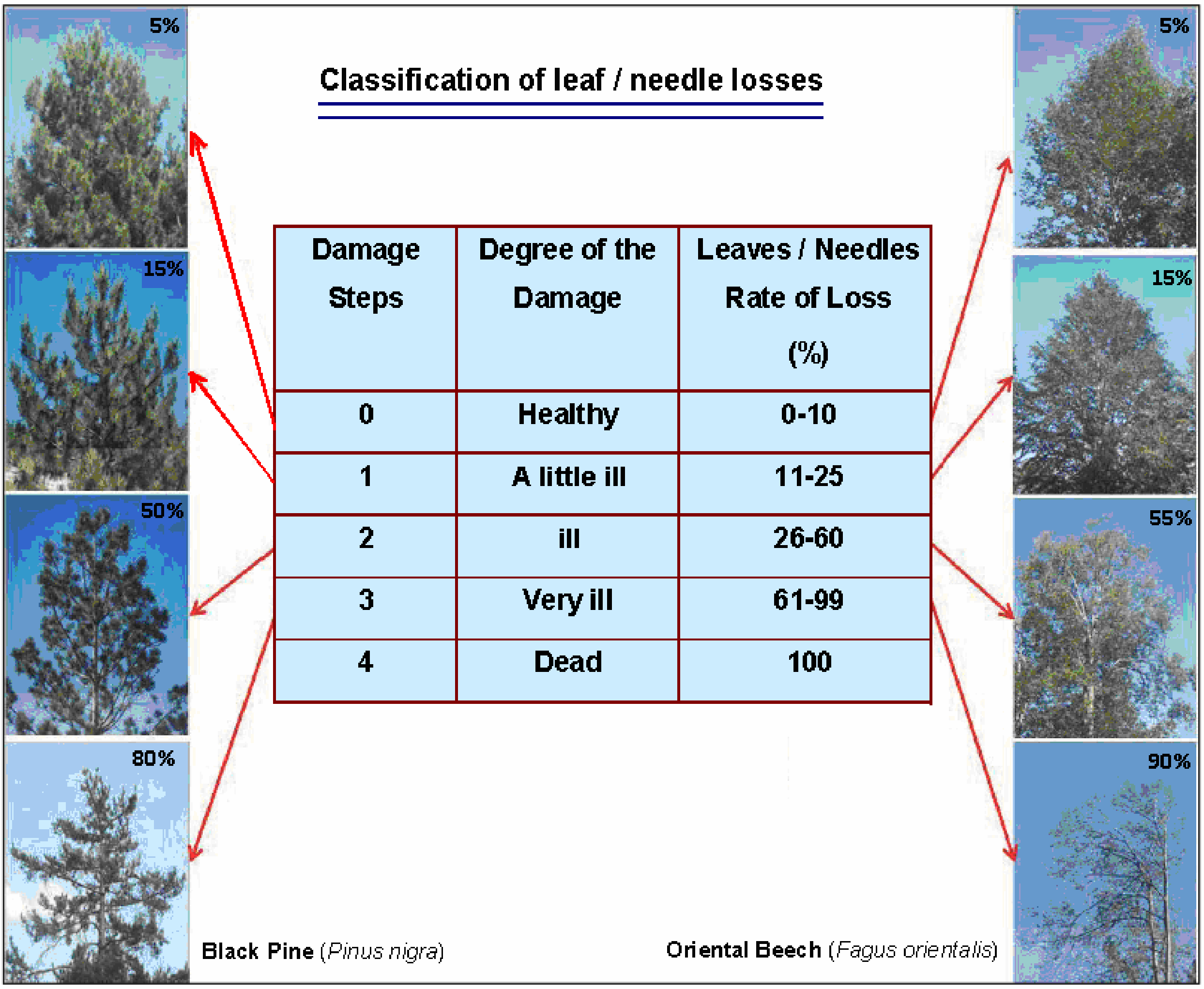


Figure 3. Tree classes according to Kraft (1= pre-dominant, 2= dominant, 3= co-dominant, 4= partly depressed, 5= totally depressed crowns) (Eichorn et al. 2010).



Damage Steps	Degree of the Damage	Leaves / Needles Rate of Loss (%)
0	Healthy	0-10
1	A little ill	11-25
2	ill	26-60
3	Very ill	61-99
4	Dead	100

Figure 4. Classification of leaf / needle losses (From UN/ECE, 2004, amended) (Photos : S. Ozturk)

The locations of the Level II observation sites where intensive monitoring studies are carried out are not determined systematically. It is targeted that the number of Level II observation sites should be at least 10% of Level I observation sites in the country. Level II observation sites should be selected so as to represent the conditions of country's major species and habitat, and thus their design may vary according to countries. However, in general, a core zone of 0,25 ha (50 m x 50 m) in size is formed in 1 hectare of homogeneous forest area (Figure 5).

Level II observation sites are divided into two subgroups according to their monitoring densities, as Standard Level II and Intense Level II sites.

In Standard Level II observation sites, studies are carried out on visual assessment of crown condition and damage factors; on soil sampling and analysis; leaf / needle sampling and analysis; tree growth, vegetation and biodiversity; and meteorological measurements.

Very extensive monitoring activities are performed in Intensive Level II observation sites, which include, in addition to the subjects in Standard Level II studies, measurements and evaluations on soil solution sampling and analysis, vegetation and biodiversity, phenological observations, air quality, deposition sampling and analysis, fall sampling and analysis, and on ozone damages. However, the timing and periods of these measurements and evaluations vary (Table 1).

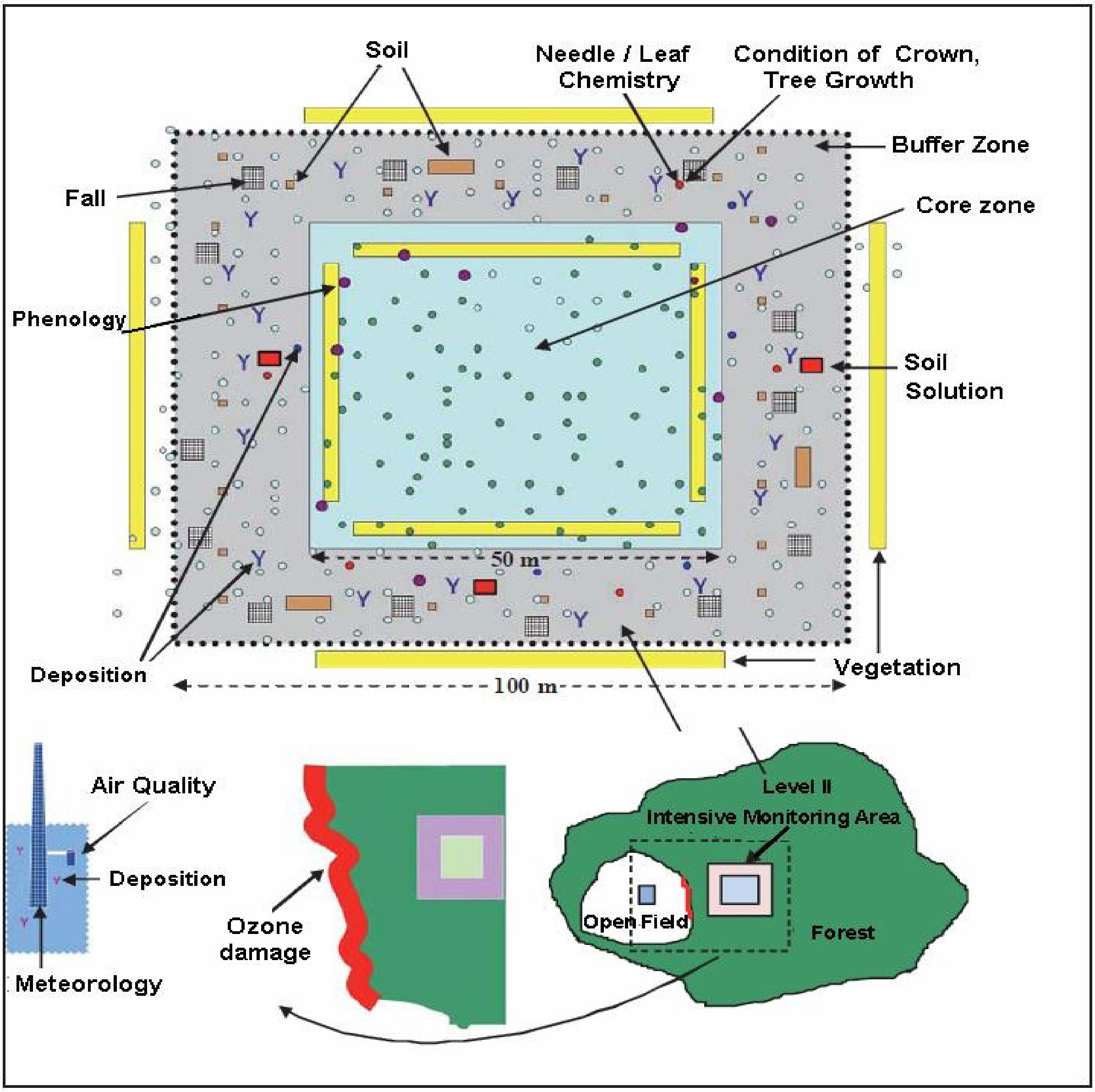


Figure 5. Studies carried out in the Intensive Level II Observation Sites

Table 1. Assessments made in Level II observations sites of various monitoring intensity in Turkey and their periods (Fisher et al., 2012)

Assessment Subjects	Standard Level II Site	Intensive Level II Site	Measurement / Observation Period
Visual Assessment of Crown Condition and Damage Factors	X	X	Every year
Soil Sampling and Analysis	X	X	Once in 10-20 years
Leaf / Needle Sampling and Analysis	X	X	Once in 2 years
Tree Growth	X	X	Once in 5 years
Vegetation and Biodiversity	X	X	Once in 5 years
Deposition Sampling and Analysis		X	Once in 2-4 weeks
Meteorological measurements	X	X	Continuously
Soil Solution Sampling and Analysis		X	Once in 1-2 weeks
Phenological Observations		X	Weekly
Air Quality Monitoring		X	Once in 1-2 weeks
Assessment of Ozone Damage		X	Year after year
Fall Sampling and Analysis		X	1-2 weeks

The reason for studying the assessment subjects given listed in Table 1 in Level II observation sites where intensive monitoring studies are conducted was the desire to determine the circulation of substances in forest ecosystems.

Forest ecosystems are called as open systems. In other words, these systems receive energy and matter inputs from the outside and also they give certain amount of energy and matter out of the system. Matter and energy inputs to forest ecosystems take place primarily by sunlight, rainfall or in gaseous form (Figure 6).

With the effects of rain, water and water-contained in nutrients (nitrate, ammonium, calcium, etc..) may enter into the ecosystem. Input in gaseous form is usually in the form of CO_2 and O_2. Especially CO_2, which is received through stomata for photosynthesis, has vital importance for plants. Certain pollutants that do not enter the forest ecosystem from the air under natural conditions may reach out to the forest ecosystems due to air pollution effects. Pollutants such as sulfur dioxide (SO_2), ozone (O_3), nitrogen oxides (NO_x) and ammonia (NH_3) also enter into the ecosystem is gaseous form and together with powders (dry deposition) or by precipitation (wet deposition). SO_2 and O_3 are received by the plants by stomas in gaseous form and they may damage leaves and chlorophyll.

Damage of the leaves may lead to thinning in the tree crowns, losses of increment and growth, and to formation of coppice / bushy trees. Even deaths can be seen in case of heavy pollution. Pollutants reaching out to the forests and soils with the rains / precipitations become harmful mostly by soil acidification. Nitrogenous compounds (nitrate, ammonium) that enter forest soil by precipitations may also act as fertilizers. Called as luxury nitrogen nutrition, these events also have a negative impact on forests. Because excess amount of nitrogen increases the need of the plant for other nutrients (phosphorus, potassium, calcium, etc.). Moreover, insufficient intake of plant nutrients may lead to nutrition disorders in the plants.

With too much nitrogen nutrition, plants experience rapid development and lack of tissue lignifications, thus resulting in such adverse outcomes as becoming weak against insect, frost or wind damages.

Gases such as SO_2, NO_x reacts with the water in the air and cause the precipitation to have an acid character. Acid precipitations leads to an increase the amount of H cation entering the soil. In fact, precipitations are of an acid character without the effects of air pollution. The reason for this is the airborne CO_2. CO_2 combines with water leading to the formation of the carbonic acid (H_2CO_3). Therefore, the pH of the rainwater ranges usually between 5.6 to 6. Precipitations with a reaction pH less than 5.6 are considered as an acidic precipitation.

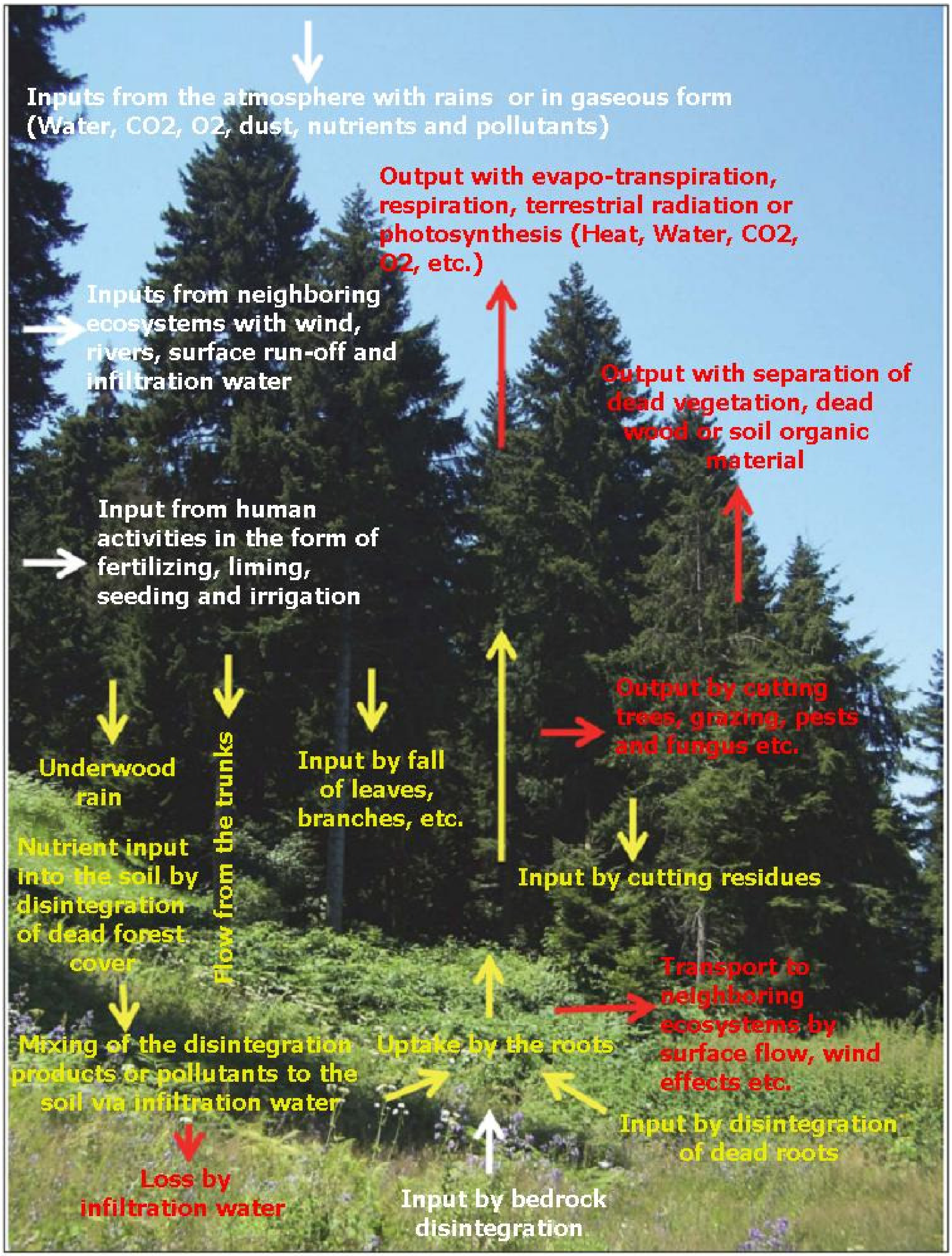


Figure 6. Circulation of nutrients in a forest ecosystem (White texts indicate inputs to the ecosystem, green texts indicate the transfers between the ponds, and the red texts indicate the outputs from the ecosystem.

Hydrogen cations of high concentration entering the soil by acid precipitation replace the alkali and alkaline-earth cations with alkaline properties, especially calcium and magnesium cations, which are washed away with the leachate (infiltration water). Consequently, the amount of H ion held in the colloidal complex (clay, organic matter and oxides in the soil) of the soil increases, and the soil acidification starts to take place (Kantarci 2000). As a result of the soil acidification, soil organisms and the root fungi (*mycorrhiza*) which contributes to the feeding of the tree die. As a result of soil acidification, decomposition of litter slows down the and thus both material circulation is prevented and organic acid formation increases.

Another negative effect of increased acidification in the soil is that aluminum, iron and manganese compounds in the soil are dissolved. In addition, clay minerals begin to be destroyed upon the fall of soil pH to below 4.2. At these pH values, the aluminum, iron and manganese ions found in the structure of clay minerals are released, and these ions results in damage to the plants. This situation poses a threat in our country, particularly in spruce forests. Also, strongly acidic soil pHs also leads to podzolization events in the soils.

In forest ecosystems, apart from the inputs from the atmosphere as gases, dusts or rainfalls, nutrient inputs take place also by the decomposition the dead vegetation (litter) and the minerals in the bedrock. Dead vegetation is the most important source of nutrients of forest ecosystems (Figure 6), and it is also the main source of many nutrients, especially nitrogen. Upon the decomposition of the dead cover, the nutrients taken by plants from the soil are again returned to the soil with the fall of the leaves. Dead vegetation is perhaps the most important point in the nutrient circulation in forest ecosystems. Because, when the decomposition of the dead vegetation is too rapid, the nutrients can not be sufficiently taken up by roots, and so they are washed away from the soil.

In the opposite situation, that is, if litter decomposition is very slow, only small amount of nutrients enter the soil and therefore plants are not fed enough. Similarly, nutrients present in the bedrock minerals such as phosphorus, potassium, calcium are converted into a form that can be taken up as by plants by decomposition.

Dead vegetation (litter) under the Oriental Beech *(Fagus orientalis)* forests, Belgrade Forest, Istanbul

Lebanon cedar *(Cedrus libani)* roots developed in the cracks of limestone bedrock

The output portion (loss) of the material circulation in forest ecosystems is comprised of leachate, grazing, timber production and surface runoff (Figure 6). Losses occur also in other elements, primarily in the carbon stock, due to burning of trees as a result of fire or by eating insects, and by fungi activities. Nutrients which are converted into the ion form as a result of both litter decomposition and bedrock dissociation are taken up by plant roots and used in nutrition. In the case of plenty of rainfall, the decomposition products (nutrients) are washed out of the soil by leachate. Removal of nutrients by leachate is increased especially when the precipitations are of acidic character, when the soils do not contain limestone and when the soils pH is below 7 (acid). Because, the H^+ ions entering the soil by acidic rainfalls replace the nutrients held by clay minerals in the soil (Hydrogen ions are held by the soil and the nutrients pass into the soil water), thus the nutrients passing into water are taken up by plants. However, the substances that can not be taken up by plants are removed from around the roots by the leakage water. If there is not enough nutrient entry into the ecosystem, soil nutrients are slowly reduced, the soil becomes further acidified (by retaining more H^+ ions in the soil), and this leads to the damage in the plants.

During the studies of forest ecosystems monitoring, the events described briefly above, called as the circulation of material, are examined. Considering that forest ecosystems are open systems, it is aimed to identify and monitor ecological processes that take place in the different parts of the ecosystem in the Level II observation sites, referred to as intensive monitoring areas. In the following section, the very purposes of the observations and analysis made in level II observation sites are described.

An overview from the Level II observation site with no.10, Antalya.

2.1. Visual Assessment of Crown Condition and Damage Factors

Parameters such as leaf/needle loss (defoliation) and color change, which were examined during crown condition assessment conducted in the areas in both Level I and Level II observation sites, provide information on health status and viability of the trees easily, rapidly and economically.

In addition, studies aiming to determine damage factors (such as insects, fungi, abiotic losses, atmospheric pollutants) in the observation sites also help to assess health status of the forests (Eichhorn et al., 2010).

Visual rating of the crown condition and damage factors are performed every year in all Level I and Level II observation sites (Figure 7).

Figure 7. Annual change of the crown status of the Crimean Pine (*Pinus nigra*) tree with No. 21 in the observation site No. 749 in Eskisehir Forest Regional Directorate (Photo: Eskisehir Regional Directorate of Forestry)

2.2. Soil Sampling and Analysis

Deposition can be determined as dry or wet deposition. Dry deposition involves determination of substances entering the ecosystem by gases and dusts while wet deposition involves the same determination for rainfalls. If wet and dry depositions are simultaneously determined, this is called total deposition (Figure 8). Ad separate determination of dry and wet deposition is not economically feasible, usually total deposition is measured in Level II observation sites (Figure 9). Measurement of dry deposition (usually in the form of dust and particulate matter inputs) is left at the discretion of the participating countries.

Measurements of total precipitation consists of collecting the precipitation reaching the forest ecosystems and measuring the concentration of certain ions inside the procurement. Samples are taken from the precipitation types called as undercover rainfall, open area rainfall and trunk rainfall (Figure 10).

The reason for this form of sampling is the fact that forest ecosystems act as a filter for air pollution. This is because, polluting gases, dust and other particles are held in the forest canopy during dry periods, and they then can reach into the standing trees by rainfalls (Figure 6). The amount of these rainfalls is measured in the field.

Figure 8. Dry and wet deposition samplers in the Level II observation site No. 10 (left) (Photo: D. Tolunay), and total deposition sampler in Level II observation site No. 6 (right) (Photo: M. Zengin).

Figure 9. Installation of total deposition samplers at Level II site (left), and rain water collected in the samplers (right) (Photo: M. Zengin).

Figure 10. Snow sampling from Level II site No. 6 (left) (Photo: S. Kiris), and sampling from the trunk flow of the Oriental Beech in Level II site No. 23 (right) (Photo: M. Zengin).

Rainfall samples were then sent to the laboratory for the analyses of the pH, electrical conductivity (EC), alkalinity, sulfate, nitrate, ammonium, chloride, total nitrogen, potassium, sodium, calcium, magnesium and dissolved organic carbon. Among the analyses specified as the compulsory in the deposition samples, first pH test is carried out in order to determine whether or not the deposition s are of acid character. Electrical conductivity (EC) is used as an indicator of the ions which increase the conductivity of the deposition waters, while the total alkalinity is a parameter related with the acidity of rainfall, which is used as the indicator of whether or not the deposition waters will cause soil acidification. Determination of the amounts of sulfate, nitrate, ammonium and phosphate ions in deposition waters is made in order to determine the extent to which these ions enter the ecosystem. High levels of these ions indicate that air pollution is involved in the area. Of these ions, particularly sulfate and nitrate may cause acidification of soils if there is not sufficient calcium in the soil or water. As for ammonium, it buffers sulfate and nitrate and ensures the neutralization of the pH of rain water provides. In addition, nitrogen compounds entering forest ecosystems by precipitation can lead to nitrogen luxury nutrition. Ca, Mg, K and Na analysis made in precipitation samples shows again the amount of the nutrient input into the forest ecosystems from the air. In addition, these ions play a positive inhibiting role in the prevention of soil acidification. Sampling for deposition should be carried out in intensive Level II observation sites (Clarke et al., 2010).

Abant, Bolu

Air quality monitoring studies conducted with passive samplers in Level II observation sites in Hamburg

2.3. Air Quality Monitoring

It was previously mentioned that pollutants reach to forest ecosystems by precipitations and by gases. Measurements for air quality observation are carried out in order to determine the levels of gaseous pollutants and to observe the spatial and temporal changes of these pollutants (Figure 6).

O_3, NO_2, SO_2 and NH_3 are the most important pollutants which have adverse effects on the vegetation. Measurement of atmospheric contaminants is carried out only in Intensive Level II observation sites and optionally (Figure 11). However, it is imperative to measure ozone (Schaub et al., 2010 a).

Figure 11 : Passive samplers used in air quality monitoring

2.4. Sampling and Analysis of Litter

Materials such as needles, leaves, branches, etc. falling from the trees (litters) is an important indicator for the amount of organic carbon and nutrients reaching to soil in forest ecosystems (Figure 6). By determining the material falling from the trees and nutrients (Ca, K, Mg, Ca, Na, P, S) reaching to soil, it is aimed to find out whether there is forest nutrition disorders in the forest. In addition to this, their contribution on the carbon stock of the forest is also determined. Materials such as needles, leaves, branches, etc. falling from the trees (litters) is also an important indicator for air pollution and climate changes.

The changes observed in the organic materials such as leaves, branches, flowers falling from the trees can be used in the diagnosis of adverse effects such as air pollution, along with natural factors such as drought, frost, insect outbreaks and wind effects. In addition, such falling can provide numerical and temporary information about the chronological development of stands. This assessment subject is studied in intensive Level II observation sites (Pitman et al., 2010) (Figure 12).

Figure 12. Litter trap and setting up traps (Photo: G. Akbin)

Soil pit opened in Level II observation site No.9, Izmir

2.5. Soil Sampling and Analysis

In this assessment subject, properties of the soil and litter are investigated. in the soil and dead forest floor. The physical (depth, stoniness, soil texture, etc.) and chemical (pH, C, N, P, K, S, Ca, Mg contents, cation exchange capacity) characteristics of the soil on which the forest grows are extremely important with respect to forest development and nutrition (Figure 6). When the listen nutrients are at appropriate levels, not only forest trees develop well but also soils may show increased resistance to pollution. For example, when soils do not contain sufficient calcium or when cation exchange capacity of the soil is low, soil acidification may develop more quickly.

Again, effects of atmospheric pollution nitrogen deposition risks can be determined with soil analysis. In addition, the amount of carbon stored in soils can also be calculated, and water holding capacity can be analyzed and thus, information concerning the evaluation of the effects of climate change can be obtained. Litter and soil sampling is required in all the areas of Level I and Level II observation sites (Fig. 13), but chemical properties to be analyzed vary according to Level I and Level II sites. Studies related with soil are repeated once every 10-20 years (Cools and De Vos, 2010).

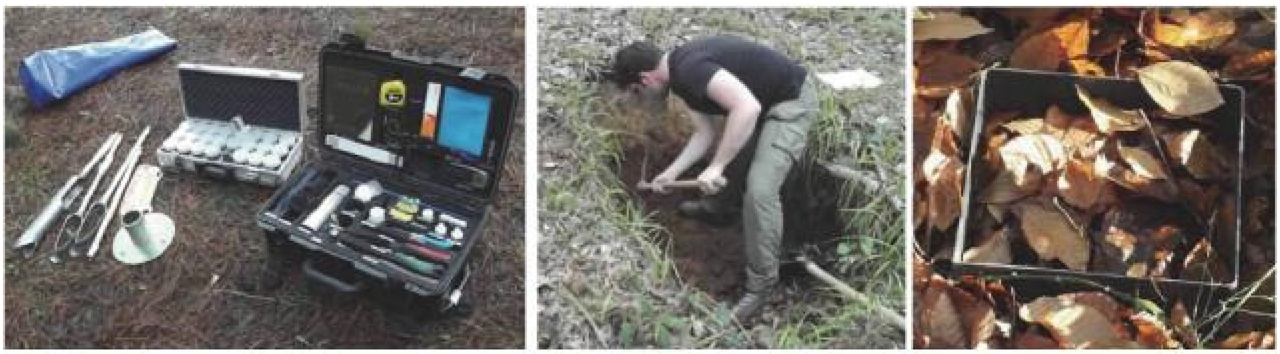


Figure 13. Taking soil and litter samples

2.6. Soil Sampling and Analysis Solution

This procedure covers sampling the water seeping from soil and analyzing the nutrients in this water in the laboratory (Figure 14). Results of soil solution analysis are used as an indicator of how much soil nutrients have been washed off from the soil. As noted previously, nutrients may be lost from the soil by leachate (Figure 6).

Soil water analysis is also an important indicator with respect to understanding whether the soil is able or not to buffer the pollutants reaching the soil with rainfall waters. In addition to this, moisture content of the soils and soil water measurements are an important parameter for determining whether or not the plants are under drought effect, and these determinations are made in intensive Level II observation sites.

Figure 14. Sampling soil solution in a Level II observation site in Hamburg.

2.7. Sampling and Analysis of Needle / Leaf

Needle and leaf analyses in all Level II observation sites are carried out in order to monitor whether nutritional status of trees and ecosystem are under the effects of air pollution (Figure 6). As for Level I observation sites, needle and leaf analyses can be analyzed optionally. It is compulsory to perform C, N, P, K, S, Mg and Ca analyzes in leaves, as all of these are macronutrients.

On the other hand, the analysis of micro-nutrients is left to the preference. Presence of deficiency in one or a few of these nutrients is indicative of malnutrition. S and N analyzes also serves to determine whether or not forests are under the influence of pollution (Rautio et al., 2010).

2.8. Tree Growth

Forest trees grow each year by the diameter and height increments. The interruptions in tree growth can be detected by the decrease of the annual ring widths, which develop as a result of cambium activities. For this reason, increment and growth measurements are used to determine viability of trees (Figure 15). Reduction in growth and increment may be an indication of the deteriorating health of the trees. Several factors have effects on the increments such as climate (rainfall, humidity, temperature, wind, vegetation period, and time of photoperiodism), soil characteristics (depth, stoniness, soil type), tree species, age and frequency (competition) of stand, shape of the earth, relationship with other living creatures (insects, fungi, other plants and so on), air pollution, and maintenance cutting made in forests.

Therefore, diameter and height of trees are measured periodically (every 5 years) in all Level I and Level II observation sites, whereby growth and increments of trees are studied. In addition, annual ring widths of trees are optionally evaluated by dendroclimatological methods in order to obtain information about the climates in the past years or to determine whether any adverse effects of air pollution on trees has occurred or not (Dobbertin and Neumann, 2010).

Figure 15. Measurement of diameter increment in Level II observation site in Hamburg (top) (Photo: D. Tolunay), and measuring diameters during the establishment of the observation sites (bottom) (Photo: M.Bilgi)

Investigation of lichens on tree trunk in Level II observation sites (Photo: N. Özel)

2.9. Vegetation and Biodiversity

Soil vegetation that cover the soil surface in forest ecosystems, which is named as living cover, plays an important role on water, nutrients and carbon cycles and on microclimate, and can directly affect soil properties. The composition, diversity and structure of soil vegetation is an important factor in the evaluation of forest ecosystems in terms of biodiversity. At the same time, it is also effective in the stages such as rejuvenation of forests, and it can be food or habitat for living creatures such as insects, birds or wild animals.

Changes in vegetation may reflect changes in ecological conditions such as soil or climate. Lichens or moss may be used as biomarker for air pollution (Figure 16). Vegetation and biodiversity assessments are conducted every 5 years in all Level II sites (Canullo et al., 2010). Preparations are underway to study this evaluation subject in Level I observation sites.

Figure 16. Lichen and moss on tree trunk

2.10. Phenological observations

Growth period for plants (vegetation period) is the time period from the onset of cambium activity and bloom of the buds in the spring until the fall of leaves and the cessation of cambium activities in autumn. Certain events occur during this period such as the appearance of needles, emerging of leaves, flowering, formation of the second shooting, autumn coloring, and fall of leaves (Figure 17). Phenology is the branch of science that studies and records the life events listed above, which occur during the growth period of the living creatures.

As in the plants, climatic conditions (temperature, wind, humidity, precipitation and evaporation) have very serious impacts also on the life events that occur periodically in other living creatures, and such creatures are able to react to changes in climate. Phenological observations made in plants may reveal problems such as climate change and fluctuations or air pollution. For example, according to phenological observations made in plants, vegetation periods were found to be increased 1-4 days in the Northern Hemisphere due to global warming effects. Phenological observations are compulsorily made in Intensive Level II Observation Sites (Beuken et al., 2010).

Figure 17. Shooting of Eastern Beech tree bud (Photo: A. Semerci)

2.11. Assessment of Ozone Damage

Ozone (O_3) is a pollutant extensively studied over the last 20 years in Europe and all over the world. Ozone actually has two varieties. Of these, the one existing in the stratospheric layer of the atmosphere is referred to as “stratospheric ozone”, “high ozone” or “benign ozone”, and this form of ozone blocks the ultraviolet (UV) rays coming from the sun from reaching the earth. Stratospheric ozone is the ozone known by almost everyone and called as ozone layer that becomes thinner under certain conditions.

Another type of ozone is “tropospheric ozone”, “low ozone” or “malignant ozone”, which is located at the lower layers of the atmosphere. This type of ozone is capable of causing significant harms on humans, animals and plants. The source of the ozone occurring close to the earth may be the transfer of ozone from the stratospheric layer to the lower layers, and its principal source is the photochemical reactions of nitrogen oxides and volatile organic contaminants. In other words, ozone is not an air pollutant generated directly as a result of such processes as industrial activities and the burning of fossil fuels.

Ozone is a pollutant occurring naturally, or as a result of chemical modification of man-made pollutants under high light intensity. The volatile organic pollutants that cause ozone formation are released into the atmosphere as a result of human activities such as traffic, organic chemicals, and the use of natural gas. Nitrogen oxides also originate from traffic activities and from burning of fossil fuels (coal, fuel oil, natural gas). Volatile organic pollutants originating from the plants such as monoterpenes and isoprenes, which naturally occur from the plants in areas where there are forests and dense vegetation, may also lead to the ozone formation. Sunlight and temperature play an important role in ozone formation. Therefore, the studies made within the scope of Europe and in the regions close to the Mediterranean have revealed that ozone concentrations are quite high and that it poses a risk to plants.

According to the studies, ozone is taken up by plants through the stomata during photosynthesis. Ozone, which is a very strong oxidizer, causes degradation of the leaf tissue when absorbed into the leaves (Figure 18). As ozone is excessively reactive and degrades rapidly by reacting with the substances in the composition of the leaves, the ozone inside the leaves can not be determined by laboratory analysis. Instead of this, by means of observations to be made in the observation sites, the ozone damage on the leaves can be followed in order to determine whether or not any ozone damage has occurred in a site. Ozone damages are only assessed mandatorily in intensive Level II observation sites (Schaub et al., 2010 b).

Figure 18. Ozone damages observed in plants in Slovenia (Photo: F. Selek).

Meteorological station in Level II observation site No. 10, Antalya

2.12. Meteorological Measurements

Meteorological variables such as precipitations, temperature, evaporation, humidity and wind may affect, adversely or positively, the composition, structure and dynamics of the forest ecosystem, the increments and growths and their health status of the forests. Also the meteorological events play a role in the exposition of an ecosystem to the accumulation of pollutants.

However, most important of all, meteorological measurements are of a great benefit in the monitoring an d evaluation of global warming and climate change events, which are the paramount issue on the agenda during recent years. In addition, meteorological measurements are also needed in the interpretation of the studies carried out in Level II observation sites, such as health status of forest ecosystems, phenological observations, ozone damage, and defoliation. Meteorological measurements are performed in all Level II observation sites (Raspe et al., 2010). It is recommended to take data at least 10% of the observation sites.

Open-field precipitation sampler, Germany

A weather station in Konya

The studies made within the scope of "Forest Ecosystems Intensive Monitoring Program (Level II)", explained so far here and based on many laboratory measurements, are carried out in order to determine forest nutrition level and to see whether the forest is under the influence on pollutants. However, the evaluation items are closely related to each other. For example, making only soil water analysis without knowing the amount of such elements as S and N entering with rainfall would not have too much of a meaning. In the forest ecosystem; analysis of SO_2 and O_3 in the air, analysis of precipitation waters, soil, leaf samples and fallen leaves, and analysis of dead vegetation can be used in the assessment of the increment of trees. Results of carbon analysis in leaves, litter and soil are used to demonstrate effects of carbon accumulation on the forest ecosystem.

In summary, the measurements and analysis within the scope of Level II seem to focus primarily on nutritional status of forests and on whether or not forests are under the influence pollution. However, the data and information obtained from these measurements and analysis may be used in many different fields according to need. The results of the analysis may also be used in various fields not directly related to "Forest Ecosystems Intensive Monitoring Program", such as insect damage (increases with nutrition deterioration or during drought), fire (drought-related), storm damage (lignification will reduce by nutrition of luxury nitrogen), increment and growth of trees (related with nutrition and climate change).

The monitoring, studies, assessments, sampling and analysis of samples performed in both Level I and Level II observation sites are conducted in all countries participating in accordance with the manuals prepared by the experts of the subjects in International Cooperation Program Forests (ICP Forests). Quality assurance and quality control are considered as the foremost important issue at every stage of the works. The countries participating in the program in Level I and Level II observation sites store the measurements and evaluations they perform in a database. This data is at the same time transferred to the head office of the Program Coordination Centre in Hamburg at the end of each year.

The data coming from the countries are assessed by the Center and Expert Panels with respect to health state of forests, effects of ozone and acid deposition on forest ecosystems, and climate change and biodiversity, and reports are prepared on European scale. In addition, accumulation of pollution, impact of this accumulation on the adaptation and on the sensitivity of forest ecosystems, cause-and-effect relationships, and time and spatial changes are also evaluated. In addition, the data collected is also used to assess the carbon sequestration potential of forests.

An overall view of Oak forests (*Quercus sp.*)

Mixed stands of European Spruce (*Picea abies*) and European Beech (*Fagus sylvatica*), Hamburg, Germany

3. HEALTH STATUS OF FORESTS IN EUROPE

Following the signing of International Cooperation Program (ICP Forests) on the Monitoring and Evaluation of Effects of Air Pollution on Forests, 13 countries submitted reports at Level I level during the first years, and during the later years, significant increase has taken place both in the number of participating countries and in the number of Level I observation sites as well as the number of trees assessed.

While evaluations were made in 44,675 trees in 1,702 Level I observation sites in 13 countries in 1988, these evaluation figures increased to 114,361 trees in 6,168 sample sites in 26 countries in 2012 (Fischer et al., 2012; Lorenz and Becher, 2013) (Figure 19). Of the assessed trees, 60,1% were coniferous trees while 39.9% were the Broadleaved type (Figure 20) (Lorenz and Becher, 2013).

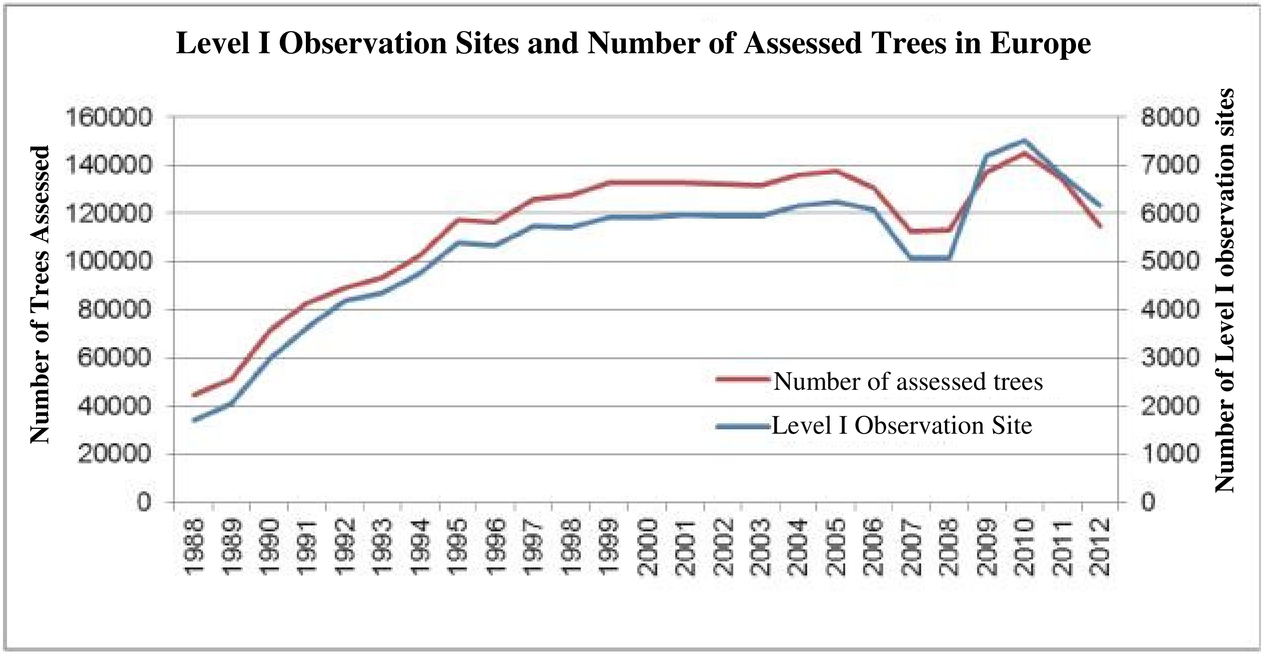


Figure 19. Level I observation sites in Europe and number of trees with crown condition assessment (Fischer and Lorenz, 2011; Fischer et al., 2012; Lorenz and Becher, 2013)

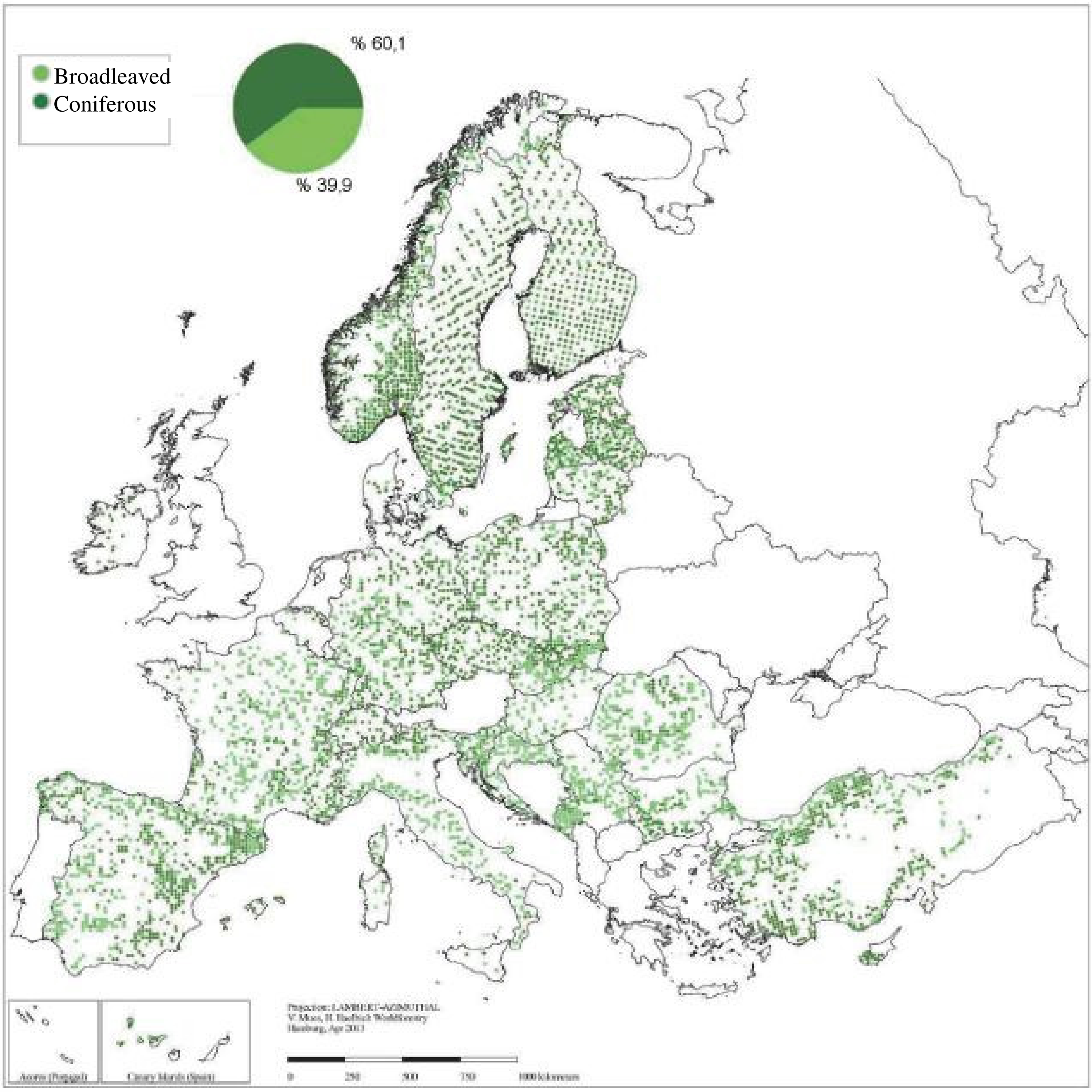


Figure 20. Level I observation sites in Europe as of the year 2012 (Lorenz and Becher, 2013)

The Program, continued over a period of 25 years, has provided important information about the health status of European forests. According to crown condition assessments made in Level I observation sites, the amount of needle loss of coniferous species was found more than the loss of Broadleaved species at the beginning of the 1990s (Figure 21). From the middle of the year 1990, the situation changed completely, and the number of damaged trees (amounts of leaf/needle loss being more than 25%, Class 2-4) in Broadleaved species, and the rate of average leaf loss exceeded the number of losses in the coniferous species.

For example, in 2012, average leaf/needle loss of all measured trees was 19.7% while this value was 19.3 % in coniferous species and 22.4 % in Broadleaved species (Figure 22). It was also determined that 1/5 of the trees assessed in 2010 were damaged (2-4.Class) (Figure 23) (Fischer et al., 2012).

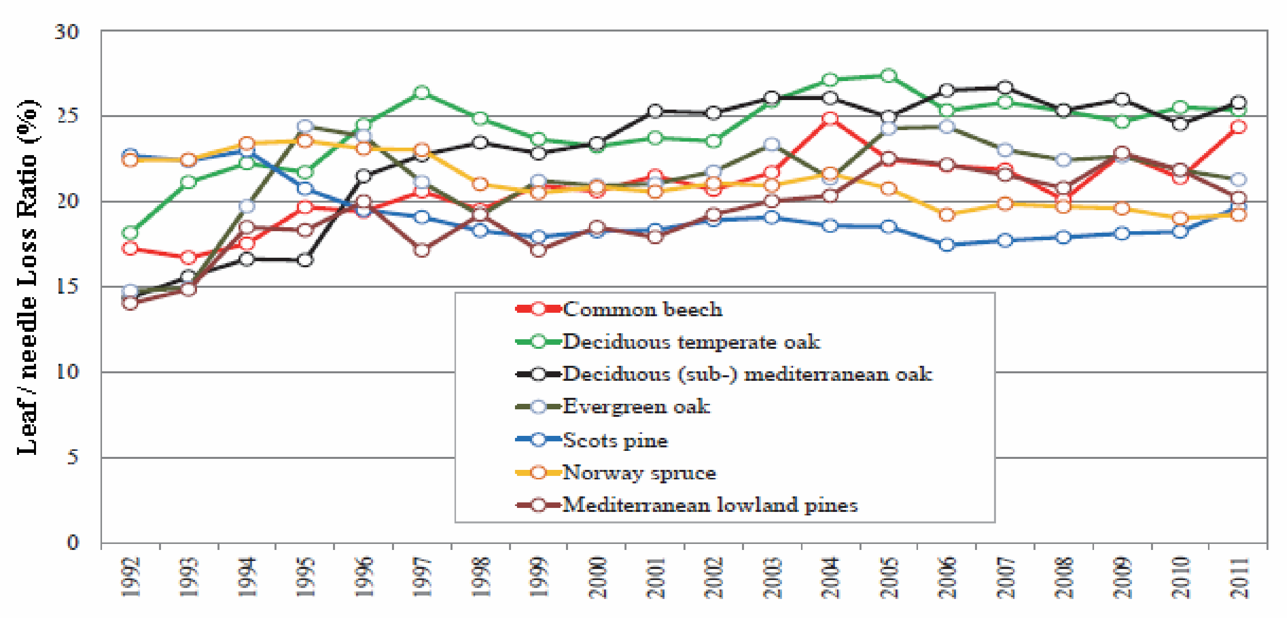


Figure 21. Change in the amounts of average leaf/needle loss (defoliation) for some tree species between the years 1992-2011 (Lorenz and Becher, 2012)

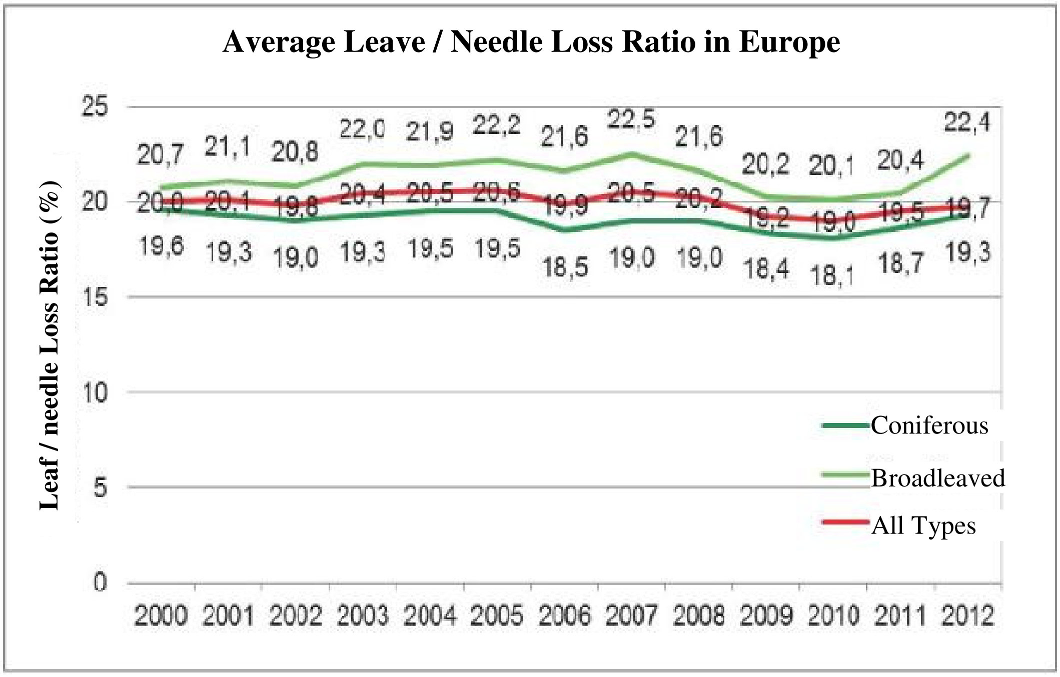


Figure 22. Average leaf/needle loss ratio in the European forests between the years 2000-2012 (Fischer and Lorenz, 2011; Fischer et al., 2012; Lorenz and Becher, 2013)

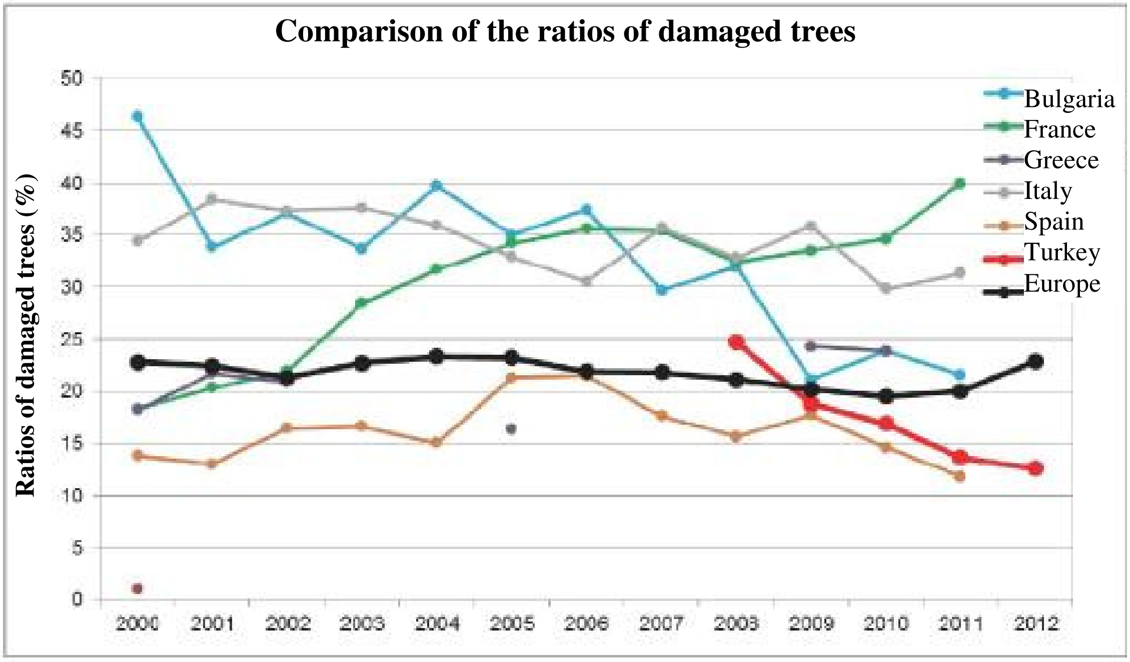


Figure 23. Ratios of damaged trees across Europe and in the countries of Mediterranean belt (Fischer and Lorenz, 2011; Fischer et al., 2012; Lorenz and Becher, 2012)

When the tree species are taken into account, while the maximum needle lost occurred in European Spruce (*Picea abies*) and Scots Pine (*Pinus sylvestris*) early in 1990s, it was determined since 1996 that leaf losses were more in temperate regions oaks (Sessile Oak (*Quercus petraea*) and Pedunculate Oak (*Quercus robur*)) and in Mediterranean Oaks (*Quercus cerris*, *Quercus frainetto*, *Quercus pubescens*, *Quercus pyrenaica*). Average leaf loss in these oak species is over 25% from 2003 until today (Figure 21). It was stated that the improvement in the health status of coniferous species compared to Broadleaved species in comparison with the higher level of needle losses during early 1990s is associated with the decrease of SO_2 emissions in Europe as a result the measures taken (de Vries et al., 2010). As a result of drought observed in Europe between the years 2003-2005, leaf losses increased in especially oak and beech species, with a slight improvement until today (Fig. 21) (Fischer and Lorenz, 2011).

It was also determined that there has occurred some regional differences in leaf/needle losses during the last 20 years. Northern Europe Forests are relatively healthy compared to Central and South European Forests, and average leaf loss remains about 15% (Figures 24 and 25). In Central Europe, leaf/needle losses increased during the drought periods between the years 2003-2005, as mentioned before, and an improvement has started since 2006 onwards. As for Southern Europe Forests, the average leaf/needle loss increased until 2005, and there has not been a very significant change after this date (Figure 25). It is thought that this situation is related to the drought and to the drying off seen in oak species (Fischer et al., 2012). Also in an another assessment made for the year 2010, it was noticed that in Southern and Central Europe forests with a deteriorating health condition compared to the previous year was more intense (Figure 26).

Of our endemic tree species, Kasnak Oak, Kazdagi Fir and Anatolian Sweetgum Tree

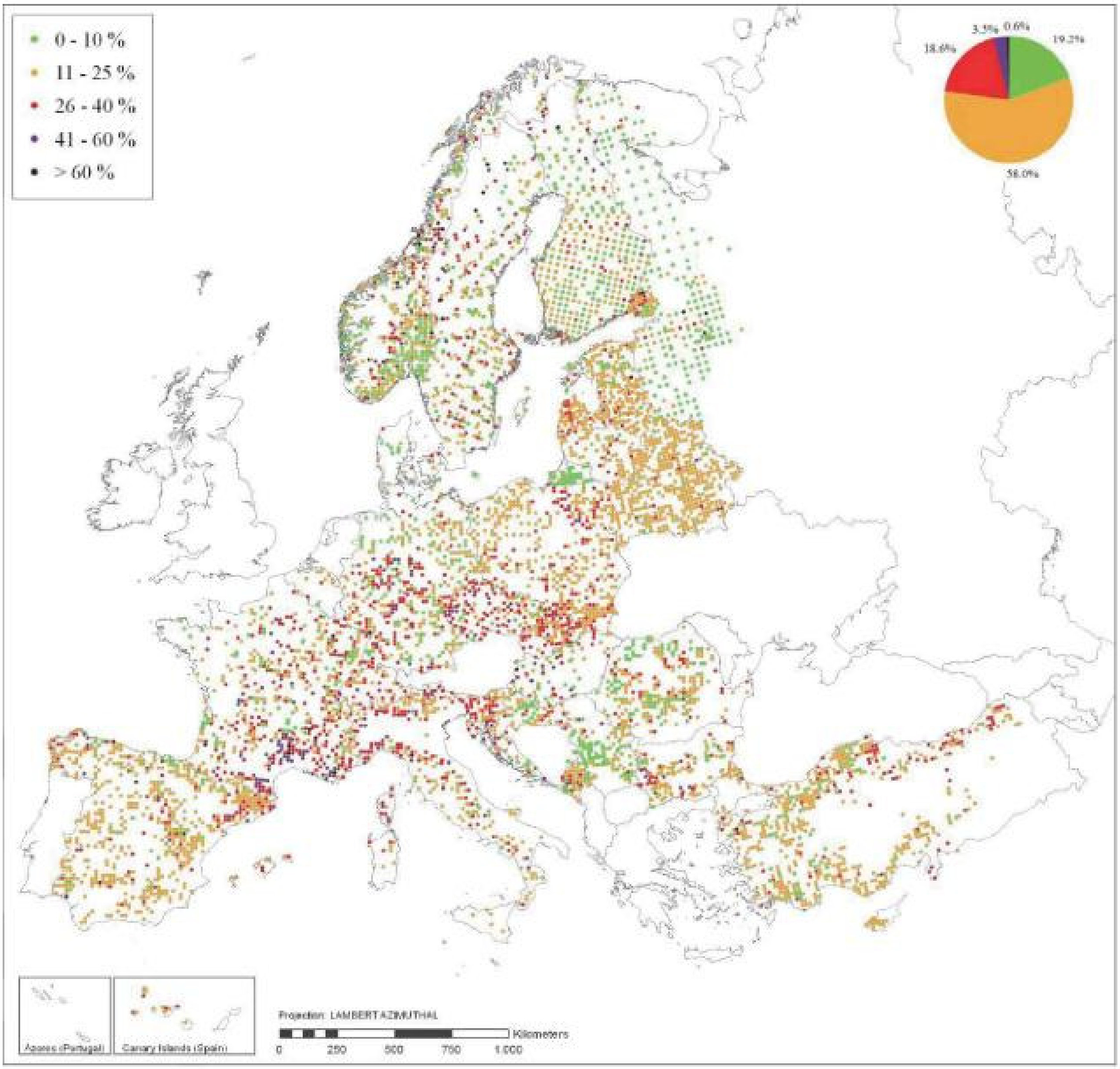


Figure 24. Average leaf/needle losses in Europe in 2011 (Lorenz and Becher, 2012)

With the studies of determining leaf / needle losses in Level I observation sites, health status of forests is evaluated in a rapid and reliable manner, just like an X-ray examination in a way. The causes of deterioration in the health status of forests can be understood with the so-called Level II intensive monitoring studies (Tables 1 and 2). For example, during the extreme drought in Europe in 2003, in parallel to the increases in leaf losses Level I observation sites, a decrease in increments was also determined in Level II sites where increment and growth was examined. At higher altitudes an increase in growth was observed.

According to the results of deposition samplings between the years 1998-2010, sulfur accumulation decreased significantly while the reduction in nitrogen accumulation was found to be less. In fact, the improvements observed in the health status of the coniferous forests since the mid 1990s are thought to have arisen from this situation. Sulfur and nitrogen deposition is higher in Central and Eastern Europe. It is suggested that there is a nitrogen surplus in Level II sites where nitrogen deposition takes place, and that this situation may lead more damage in trees than additional stress factors such as frost, storms and insect damage (Fischer et al., 2012).

Table 2. Number of Level II observation sites in Europe (Fischer et al., 2012)

Assessment Subjects	Number of Level II Site in the Database[1]	Number of Level II Site Assessed in 2010
Visual Assessment of Crown Condition and Damage Factors	763	565
Soil Sampling and Analysis	270	62
Leaf/needle Sampling and Analysis	568	112
Tree Growth	365	100
Deposition Sampling and Analysis	487	311
Vegetation and Biodiversity	165	92
Meteorological Measurements	314	233
Soil Solution Sampling and Analysis	270	62
Phenological Observations	228	131
Air Quality Monitoring	301	164
Assessment of Ozone Damage	147	124
Shedding Sampling and Analysis	294	172
Leaf Area Index2	156	145
Soil Moisture / Water2	93	47

[1] Sites providing data for at least one year between 2006-2010
[2] New examinations covering the years 2009 and 2010

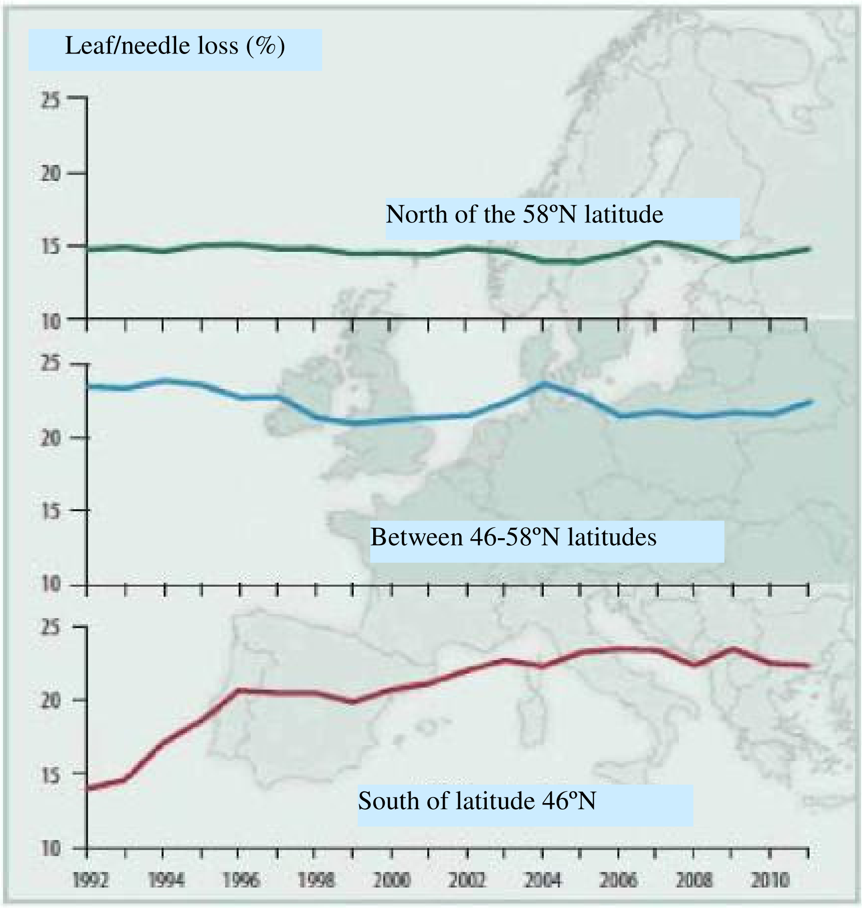


Figure 25. Amounts average leaf/needle losses for all tree species in Northern, Central and Southern Europe between the years of 1992-2011 (prepared using data from 14 countries) (Fischer et al., 2012)

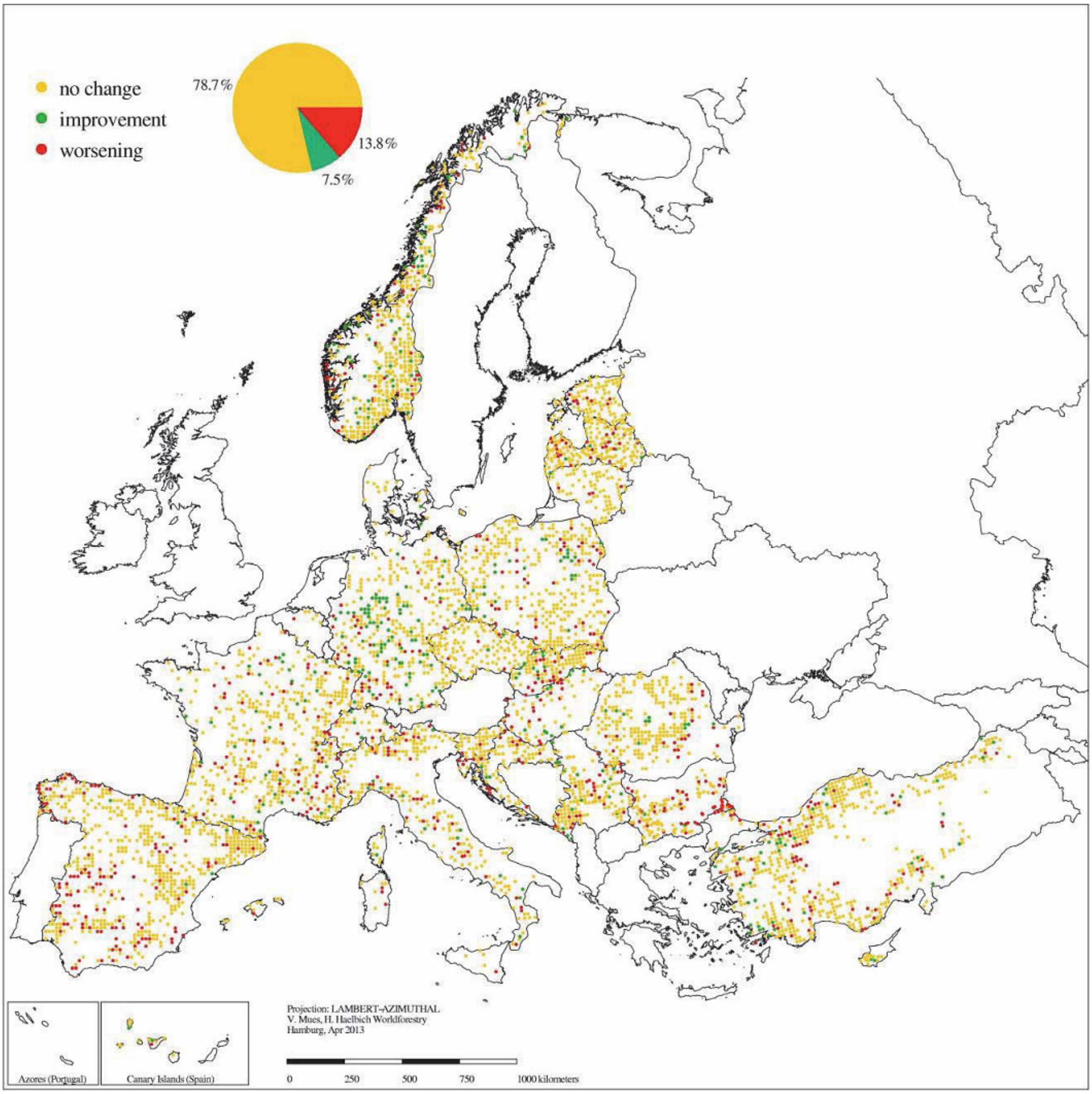


Figure 26. Change of leaf/needle losses between 2011 and 2012 (Lorenz Becher, 2013)

With the help of the data obtained from Level II observation sites, various models for future predictions can also be made. For example, it has been demonstrated with the help of models that net primary production of forests will also increase in the years ahead upon the increase of CO_2 concentration in the atmosphere.

Also according to the model studies, it is estimated that the critical limit for nitrogen deposition will be exceed in 30% of Level II observation sites in 2020 (Fischer et al 2012).

Uludag Fir (*Abies nordmanniana subsp. bornmulleriana*) Forest, Gölcük, Bolu

4. MONITORING OF FOREST ECOSYSTEM STUDIES IN TURKEY

Although Turkey is a long-time member of ICP Forests program, relevant follow-up studies could not be initiated timely. Though, at the beginning of the 2000s, studies were launched around Kocaeli Peninsula by Research Institute for Poplar and Fast-Growing Exotic Species Forest Trees, and around Eskisehir by Forest Soil and Ecology Research Institute, but these studies could not be continued. After Netherlands' decision to include Turkey in the MATRA and PSO Programs, which it started in 1994 in order to provide assistance to Central and Eastern European countries, a Memorandum of Understanding was signed between the Netherlands and Turkey; thereafter, the project entitled "Developing Forestry Information System for Sustainable Forest Management in Turkey", with project no. PP 05/TR/7/7, was launched in January 2006 within the scope of the abovementioned programs. With this project, it was aimed to develop a Forestry Information System within GDF structure and to ensure the followings through mechanism to be established:

- Providing forest fire statistics in appropriate standards to EFFIS (European Forest Fire Information System) over a database to be developed,
- Ensuring data and information exchange at EU standards between EFICS (European Forestry Information and Communication System) and in particular GDF, over a database to be developed,
- Launching Level I and Level II programs in forest areas in order to monitor our country's forest ecosystems, reporting forest condition on a regular basis over the database to be developed, and establishing cooperation in this context with the UN Economic Commission for Europe and EU European Commission.

And the project was completed in April 9, 2009. After completion of the project, monitoring studies for forest ecosystems were also continued.

After disbanding of Ministry of Environment and Forestry and establishment of Ministry of Forestry and Water Affairs in 2011, Forest Ecosystems Monitoring Branch Directorate (FEMBD) was set up under Forest Pests Control Department (FPCD) of General Directorate of Forestry (GDF), and Forest Ecosystem Monitoring Program attained a corporate identity. Currently, a communiqué is under preparation, which will describe the persons responsible for the program and the tasks they will undertake. According to the said communiqué, there is an Executive Board at the top of the corporate organization of Forest Ecosystem Monitoring Program.

The Board consists of a President who is the relevant GDF Deputy Director, a Co-President who is the Head of Forest Pests Control Department, Members who are the heads of respectively Foreign Relations, Education and Research Department, Forest Management and Planning Department and Information Systems Department, and the National Focus Centre Head, and Forest Ecosystems Monitoring Branch Director. The main tasks of Executive Board include to solve the problems encountered in implementing the program; to analyze budget proposals specifying the needs such as personnel, software, hardware and equipment; to make decisions on the budget; to consider and decide on the legal, financial and corporate structuring to be established in parallel to new approaches and strategies within the scope of the International Cooperation Program Forests and Forest Ecosystem Monitoring Program.

Scientific support to the program is provided by Scientific Advisory Board to which academicians from various universities are members. The main tasks of this Advisory Board include to ensure the development of Forest Ecosystem Monitoring Level I and Level II Programs in line with international processes and with national programs such as Turkish National Forest Inventory; to prepare training programs; to provide contributions to the national and international reports to be prepared within the scope of the Program; and to produce thematic reports, as necessary, that will enable decision-makers to establish strategies.

Forest Pests Control Department assumes the task of National Focus Centre of the Program, which it implements through its Forest Ecosystems Monitoring Branch Directorate. National Focus Centre has tasks such as to ensure coordination between Level I and Level II programs; to follow the international relations; to conduct correspondences; to inform the Executive Board; to archive all information and data obtained under the program, and preparing documentation of the same.

Level I and Level II Coordination Points assume such tasks as preparing work plans for the works to be carried out under Level I and Level II programs for which they are responsible; following the same and making their installations; ensuring the archiving of the resulting data; ensuring quality assurance and quality control; organizing training activities, organizing national and international meetings; and ensuring the coordination with National Focus Center. Level I Coordination Point consists of an expert from Forest Pests Control Department, and Level II Coordination Point consists of one each experts from Foreign Affairs Department and Education and Research Department.

Oak - Beech mixed stands, Bahcekoy, Istanbul

The tasks carried out by the national experts responsible for the assessment include such duties as ensuring that the evaluations made within the scope of the program are carried out in accordance with the relevant methodology; preparation of the implementation and inspection manuals for their expertise subjects; performing audits and ensuring the quality assurance, following national and international developments and reflecting these to the applications; preparing training programs; ensuring coordination with the relevant departments; preparing budget proposal by defining tools, equipment, software, hardware and personnel needs; data storage and archiving; filling in the relevant table for international reporting, and preparation of technical reports. In addition, for each subject of evaluation under the program, regional experts carry out healthy execution and supervision works for field studies.

Visual assessment studies for the crown condition and damage factors within the scope of the Level I and Level II of the program are carried out by at least two technical staff assigned by Regional Forestry Directorates. As for the sampling and observations studies on phenology, precipitation, soil solution, air quality and litter-fall subjects, which have to be performed in Level II observation sites weekly or at certain periods, these works are carried out by responsible field staff.

As other works performed in Level II observation sites require expertise, these works are carried out by researchers from the Forest Research Institute.

In 2006, teams were formed and training was began within the scope of the program for the installation of Level I sites. After that, the teams that will make the visual assessment of the crown condition and damage factors in Level I and Level II observation sites were included in the training. As the visual assessment of crown condition and damage factors is a subjective evaluation, training of the teams employed in the assessment activities is very important. For this reason, training activities are continued every year in different ecological conditions and with different tree species in order to ensure proper training of the teams (Figure 27).

In addition, work was started in 2006 to prepare a catalog showing the trees with different leaf/needle loss values of the important tree species of out country, which would be used in the assessment of the crown condition and damage factors of the forests, and the catalog was printed in 2009 (Özturk, 2009). Due to the needs perceived for the identification of tree species, especially Oak species, the Identification and Diagnosis Guide for Oaks in Turkey was printed and distributed in 2013 (Özturk, 2013).

Figure 27. Trainings conducted within the scope of the Forest Ecosystems Monitoring Program (Photo: S. Özturk)

While the studies related with Level I observation sites are continuing, studies have also launched for the determination of the numbers and locations of Level I observation sites where intensive monitoring workbench made. The responsibility of the studies to be carried out in Level II observation sites were assumed in the early years by Research and Development Department of Ministry of Environment and Forestry. After the year of 2011, this responsibility was transferred to the Department of Foreign Relations and Education Department of GDF. During 2006, national experts were specified and assigned for each of the assessments to be made in Level II observation sites, most of whom were the researchers employed in Forestry Research Directorates. In addition, a Scientific Advisory Board was established with the support of the universities. The Scientific Advisory Board and national experts started to examine the handbooks / manuals of ICP Forests programs, and the national experts were assigned to participate in the abroad training sessions. Then the said handbooks / manuals were translated, experts to work on the assessment subjects were assigned, and implementation and inspection manuals were prepared for each of the evaluation subjects (Figure 28).

Meanwhile, a database where the to be collected from Level I and Level II observation sites would be loaded, and a web page where the program results would be published were also prepared (Figure 29).

As a precise analysis is required for the samples to be taken from especially Level II observation sites such as fallen leaves / branches etc. water, soil, leaf/needle materials, the laboratories of Forestry Research Institute were inspected and as a result it was decided to set up a new laboratory under Aegean Forestry Research Directorate (Figure 30). The establishment of this laboratory and the training of laboratory staff were completed, and in 2014, it is planned to begin the analysis of the materials collected from the observation sites.

As a result of the cooperation under the protocol made with MGM for meteorological measurements in Level II observation sites, the purchase 13 stations were completed, and the installation of these stations will be made during the year 2013. During 2014-2015 years, it is targeted to set up weather / meteorological stations in all of the Level II observations with a total number of 50.

Apart from these activities, annual review meetings are conducted regularly every year. Since 2007, the results of crown condition assessment studies in Level I observation sites are sent to Program Coordination Centre in Hamburg (Figure 31).

Although our country started monitoring works much later than other European countries, significant progress was obtained and a meeting referred to as Panel of Experts was held in Antalya in 2011, to which experts on vegetation and biodiversity participated (Figure 32).


EL KİTABI

T.C.
Çevre ve Orman Bakanlığı
Orman Genel Müdürlüğü
Orman İdaresi ve Planlama Dairesi Başkanlığı

ORMAN EKOSİSTEMLERİNİN İZLENMESİ
SEVİYE I (LEVEL I) PROGRAMI
Seviye I Daimi Gözlem Alanı Aplikasyon Kılavuzu

Ankara – Ağustos 2007

Figure 28. Manuals for installation and assessment, and for supervision and application.

Figure 29. Various publications and web pages published within the scope of Monitoring of Forest Ecosystems Program

Figure 30. Soil and Ecology Laboratory in Aegean Forestry Research Institute, where the samples to be taken within the scope of the ICP Forests are to be analyzed (Photo: Aegean Forestry Research Institute)

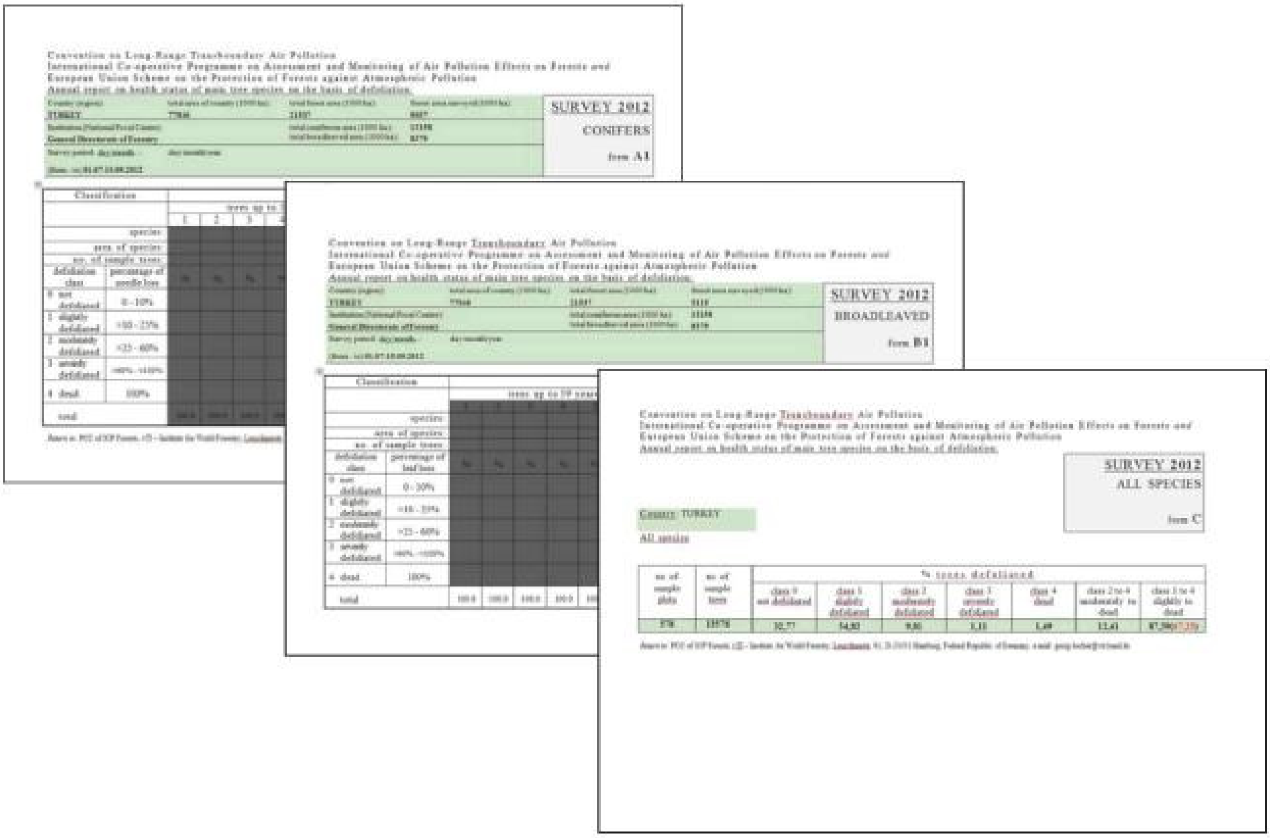

Convention on Long-Range Transboundary Air Pollution
International Co-operative Programme on Assessment and Monitoring of Air Pollution Effects on Forests and
European Union Scheme on the Protection of Forests against Atmospheric Pollution
Annual report on health status of main tree species on the basis of defoliation
SURVEY 2012
CONIFERS
form A1
SURVEY 2012
BROADLEAVED
form B1
SURVEY 2012
ALL SPECIES
form C
Country TURKEY
All species

Figure 31. Reports and statements sent to Program Coordination Centre

Figure 32. Participants of the Panel of Experts on vegetation and biodiversity held in Antalya in 2011 (Photo: N. Özel).

Mixed stands of Lebanon Cedar (*Cedrus libani*) and Syrian Fir (*Abies cilicica*) in Mut, Mersin

5. HEALTH STATUS OF TURKEY'S FORESTS

The first data at Level I level of forest ecosystems monitoring studies, which began in Turkey in 2006, was obtained in 2007. Reports on crown condition assessments and damage factors are presented Program Coordination Center of International Cooperation Program Forests since 2007.

The works in this field, which started in Turkey in 2006 by the establishment of 35 Level I observation sites, continued by 2012 and during this period a total of 818 Level I sites were set up 16 x 16 km grid network (Figures 33 and 34, Table 3).

However, in a part of these sites crown condition assessments could not be made as there were not trees suitable for assessment due to rejuvenation (trees of Class 1, 2 and 3 according to Kraft classification, with a diameter of 5 cm at a height of 1.30 m, mechanically undamaged by more than 50%). These points were placed under monitoring, and assessment of the tree crown condition after the trees have reached to the criteria. When considered in terms of Regional Directorates, the highest number of Level I observation site are located in Amasya Regional Directorate of Forestry, followed by Kastamonu, Antalya, Balikesir and Mugla Regional Forestry Directorates (Table 3).

Figure 33. Installation of Level I observation site (Photo: M.Bilgi)

Figure 34. Level I observation sites with completed installation as of 2012

Table 3. Distribution of Level I observation sites among Regional Forestry Directorates as of 2012

Regional Forestry Directorates	Level I Observation Sites		
	Valid	Valid (Under Follow-up	Total
Adana	20	4	24
Adapazari	16	1	17
Amasya	52	24	76
Ankara	24	9	33
Antalya	33	18	51
Artvin	12	1	13
Balikesir	40	9	49
Bolu	27	2	29
Bursa	20	8	28
Denizli	23	11	34
Elazig	11	3	14
Erzurum	14	15	29
Eskisehir	20	6	26
Giresun	13	1	14

Regional Forestry Directorates	Level I Observation Sites		
	Valid	Valid (Under Follow-up	Total
Isparta	21	20	41
Istanbul	18	8	26
Izmir	16	0	16
Kahramanmaras	13	16	29
Kastamonu	51	4	55
Kayseri	11	9	20
Konya	21	10	31
Kütahya	19	8	27
Mersin	28	8	36
Mugla	36	11	47
Sanliurfa	11	2	13
Trabzon	16	4	20
Zonguldak	16	4	20
Total	602	216	818

Visual assessment of crown condition and damage factors can not be made for various reasons in all the installed Level I observation sites. However, the number of evaluated Level I sites reached 578 over time (Figure 35). Number of trees assessed between 2007 – 2012 increased to 13,602 from 941 (Figure 36). The number of trees evaluated in Level I observation sites constitutes about 10% of the number of trees evaluated all over Europe.

Approximately 37% of the trees evaluated in our country within the scope of the forest ecosystems monitoring program are Broadleaved trees, and 73% are coniferous species.

Leaf/needle loss has been assessed in 60 different tree species within the scope of the program, Red Pine (*Pinus brutia*) being the most evaluated one; proportionally, it constitutes 24% of all trees evaluated (Table 4). After Red Pine, the order of highest evaluated individuals of observed species is Oak species (*Quercus sp.*), Black Pine (*Pinus nigra*), Juniper species (*Juniperus sp.*) and Beech (*Fagus orientalis*) (Table 4). Only one tree could be be evaluated in species of Flowering Ash (*Fraxinus ornus*), Carob (*Ceratonia siliqua*) and Cypress (*Cupressus sempervirens*).

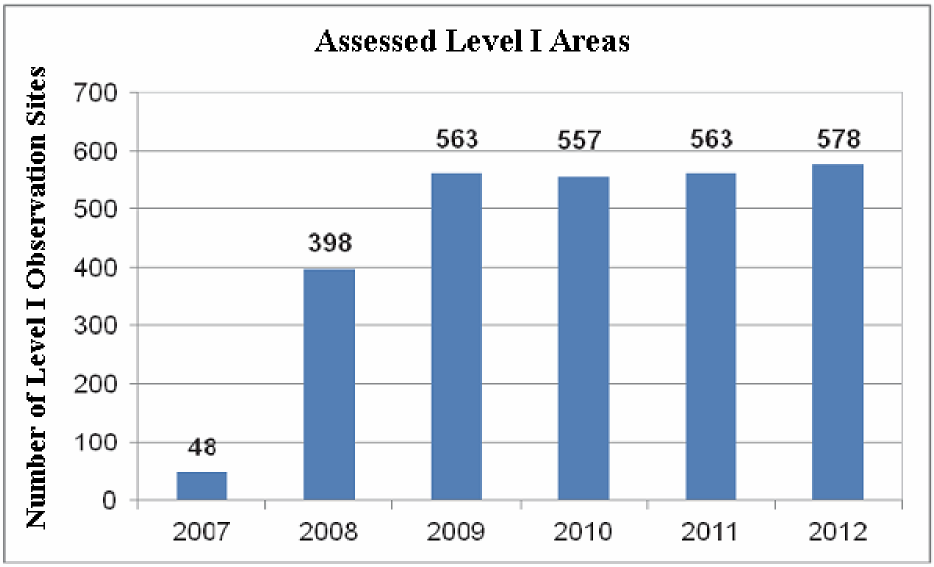


Figure 35. Annual change of Level I areas where crown condition assessment is made in Turkey, according to years.

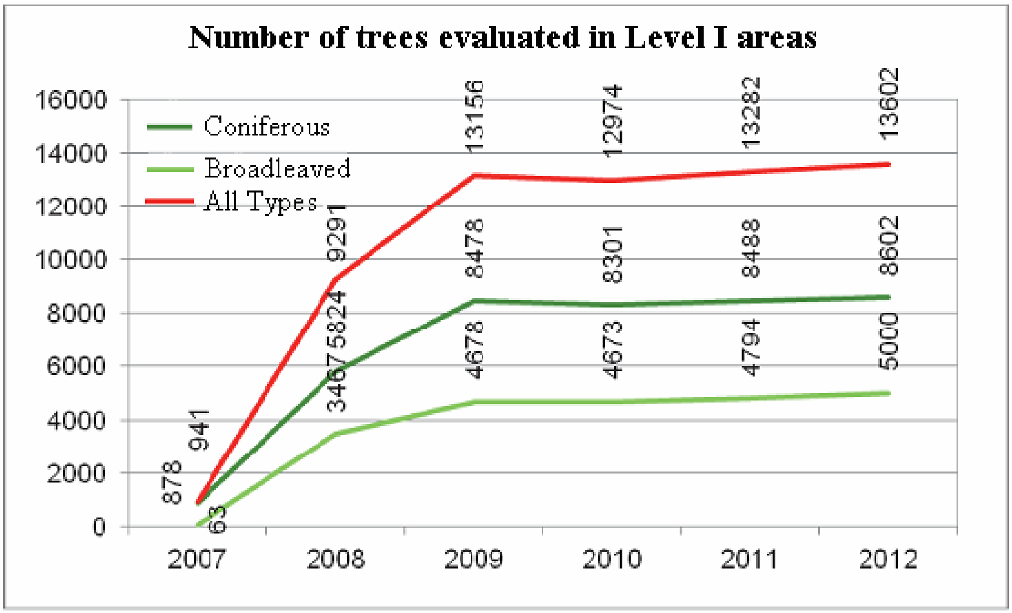


Figure 36. Annual change of the number of trees with completed crown assessment.

Table 4. Distribution of the numbers of the evaluated trees according to the species by year

Tree Species			2007	2008	2009	2010	2011	2012
Broadleaves species	Oriental Beech	*Fagus orientalis*		815	866	938	934	981
	Turkey Oak	*Quercus cerris*	9	709	872	915	976	1045
	Sessile Oak	*Quercus petraea*	14	397	645	612	623	596
	Downy / Pubescent Oak	*Quercus pubescens*		286	347	311	363	366
	Gall Oak	*Quercus infectoria*	4	147	187	187	199	256
	Pedunculate / English Oak	*Quercus robur*		71	195	199	194	209
	Kermes Oak	*Quercus coccifera*		150	153	152	148	150
	Hungarian / Italian Oak	*Quercus frainetto*	4	76	112	112	112	117
	Oriental Hornbeam	*Carpinus orientalis*	1	141	147	160	142	177
	European Hornbeam	*Carpinus betulus*		109	131	129	132	129
	Anatol./ Sweet Chestnut	*Castanea sativa*	19	57	115	114	115	115
	Other Oak Species			79	136	148	138	148
	Other Brdleavd. Species		12	430	772	696	718	711
	Broadleaved Total		63	3467	4678	4673	4794	5000
Coniferous Species (Pinales)	Calabrian Pine	*Pinus brutia*	826	2065	3226	3120	3258	3253
	Crimean Pine	*Pinus nigra*	29	1855	2434	2473	2465	2485
	Scotch Pine	*Pinus sylvestris*		500	806	723	780	800
	Greek Juniper	*Juniperus excelsa*		589	740	702	726	783
	Caucasian / Kazazdagi Fir	*Abies nordmanniana*		223	238	257	251	260
	Lebanon Cedar	*Cedrus libani*		157	180	180	179	180
	Eastern Spruce	*Picea orientalis*		100	127	133	134	134
	Syrian / Cilician Fir	*Abies cilicica*		65	111	109	108	109
	Stinking Juniper	*Juniperus foetidissima*		86	101	99	100	125
	Prickly Juniper	*Juniperus oxycedrus*		96	104	97	82	108
	Common Juniper	*Juniperus communis*		31	55	55	31	32
	Other Needled Species		23	57	356	353	374	333
	Needled Total		878	5824	8478	8301	8488	8602
	Gross Total		941	9291	13156	12974	13282	13602

There have been significant increases in the numbers and types of the assessed trees until 2012 from the time when the first crown condition assessment was started in 2007 (Figure 36 and Table 4). Therefore, temporal variation leaf/needle loss ratios of the monitored trees, which we can use as an indicator of forest health state, was evaluated for the period between 2008-2012. When the leaf/needle losses are considered together with all tree species, the year 2008 stands out as the year when the amount of average leaf/needle loss was maximum with a figure of 27.1%. Between the years 2009 and 2011, an improvement occurred in the health status of our forests and the average leaf/needle losses declined, decreasing to 19.0%. In 2012, there was not much change compared with the previous year, with the average leaf/needle loss being found to be 19.2%.

When broadleaved and coniferous species compared with each other, it is worth to note that the loss in broadleaved species is more.

The damage due to losses in broadleaved species was quite high especially in 2008, with the average amount of leaf loss being determined as 27.1%. Improvements were observed during the following years in the health status of the broadleaved species, and amount of leaf losses dropped to 21.0% in 2011. In 2012, it showed a slight increase, rising to 21.4%. A similar trend was observed also in coniferous species between the years 2008-2012, which had lower amounts of needle losses. Average amount of loss in coniferous species in 2012 compared to the previous years did not change (Figure 37).

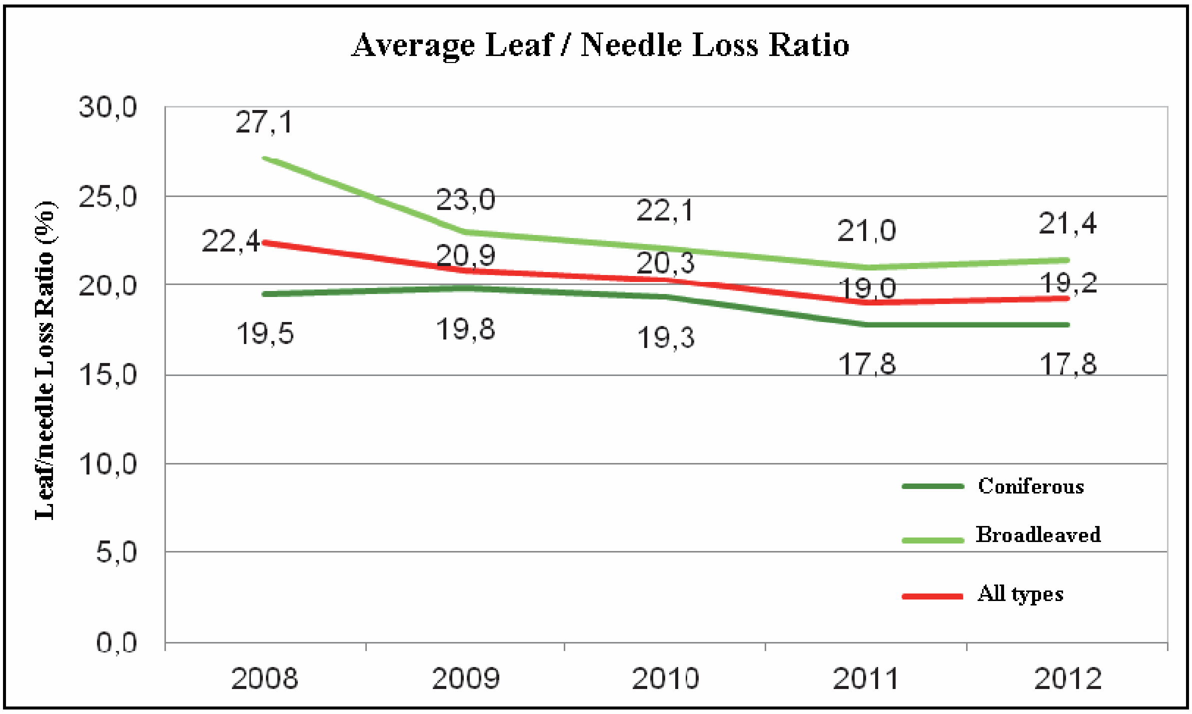
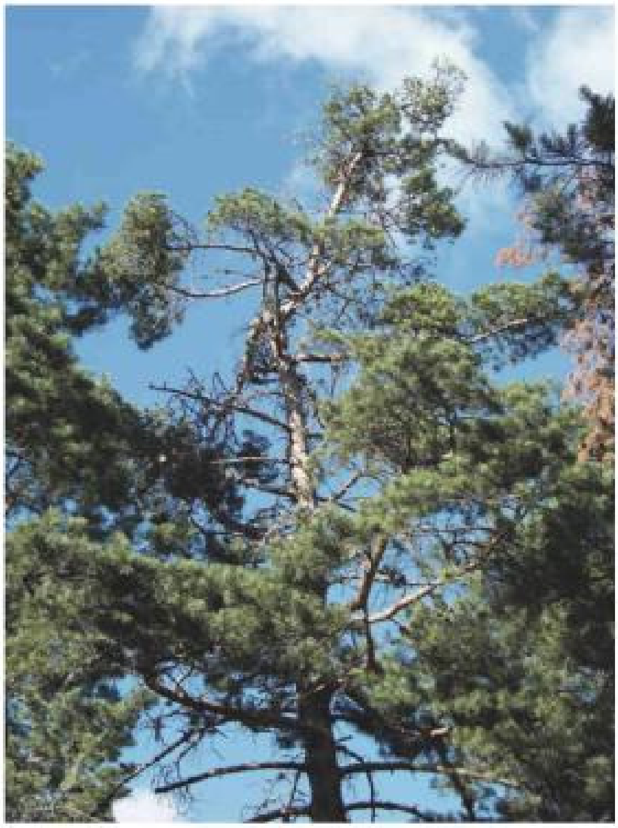
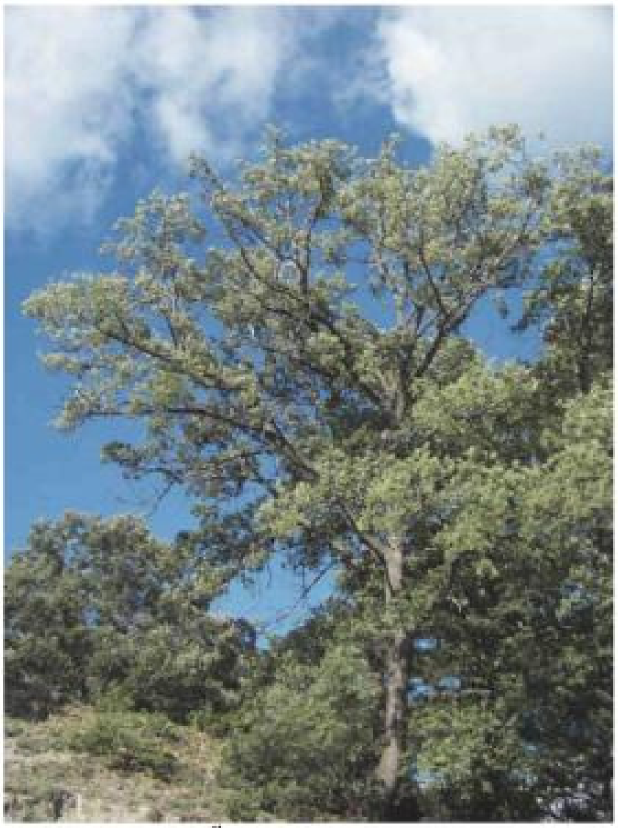


Figure 37. Change of the average leaf/needle loss (defoliation) amounts between the years 2008-2012.





Leaf / needle losses in Scotch Pine and Oak trees (Photo: S. Özturk)

Defoliation observed in the crowns of Oak leaves in Igneada

Under the International Cooperation Program Forests, trees with leaf/needle loss amount less than 25% are considered as (Class 0-1) healthy, and those with more than 25% are considered (Class 2-4) damaged (Figure 2). Accordingly, the ratio of the trees considered damaged continuously decreased since 2008 until 2012, declining to 12.6% from 24.7% (Figure 38).

As in European Countries implementing Forest Ecosystems Monitoring Program, the ratio of damaged broadleaved species is higher than damaged coniferous species in our Country as well. However, the ratio of damaged trees in both broadleaved and coniferous species demonstrated a continuous decrease between the years 2008-2012, which is a sign that there has been an improvement in the health status of the tree during the last 5 years (Figure 38).

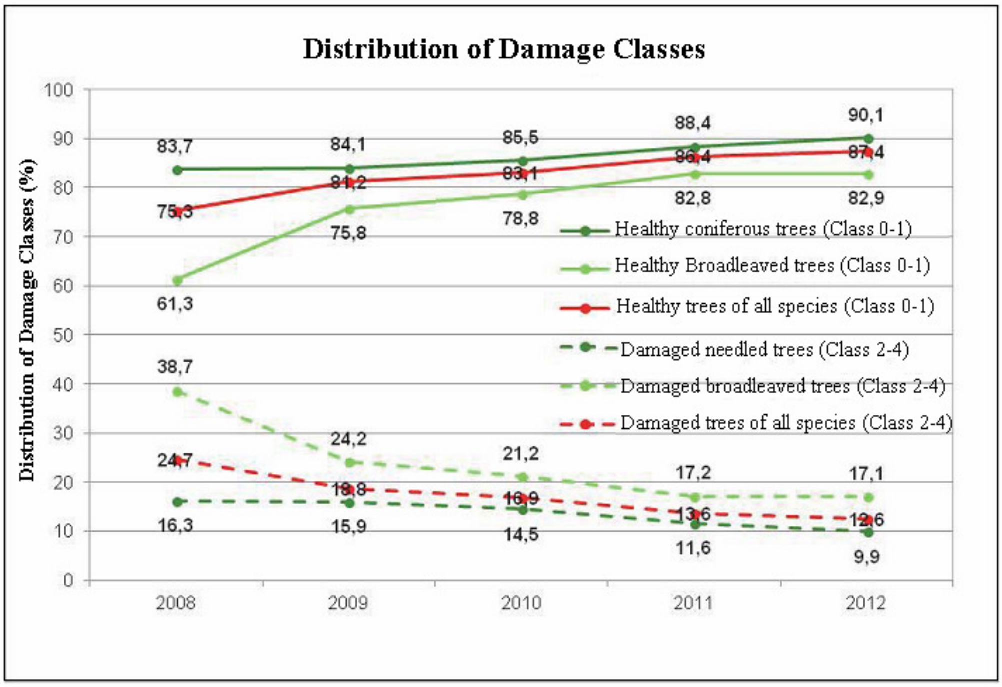


Figure 38. Distribution of damage classes of broadleaved and coniferous trees assessed at Level I level.

Changes of leaf/needle loss ratios according to the tree species are given in Table 5 and Figure 39. The highest average leaf loss ratio in broadleaved trees in 2008 was found to be, respectively, in Downy / Pubescent Oak (*Quercus pubescens*) by 41.9% and in Sessile Oak (*Quercus petraea*) by 34.6%. Pubescent Oak (*Quercus pubescens*) showed leaf loss ratios over 30% in all the assessment years, and it is the species drawing attention by being the most damaged tree species (Figure 40). Although leaf loss ratios in Sessile Oak species decreased over time in comparison to 2008 and it is less than 30%, it holds the second rank among the damaged trees.

In European Hornbeam (*Carpinus betulus*) and Oriental Hornbeam the (*Carpinus orientalis*) species, which have the highest leaf loss value in 2008, health status improved in other years, and in 2012, average leaf loss decreased by 10% compared to 2008. Sweet Chestnuts (Castanea sativa) species is remarkable in that it is the tree with the least changes in loss ratios during the 5-year period. The leaf loss ratio in this species is around 25% constantly during the 5-year period, and it is the third most damaged tree species in 2012 (Table 5 and Figure 39).

Table 5. Variation of average leaf/needle loss according to tree species and year

Tree Species			2007	2008	2009	2010	2011	2012
Broadleaves species	Oriental Beech	*Fagus orientalis*	27.4	20.5	18.3	16.9	17.0	27.4
	Turkey Oak	*Quercus cerris*	22.4	20.1	20.0	17.6	19.9	22.4
	Sessile Oak	*Quercus petraea*	34.6	27.6	28.8	30.1	26.8	34.6
	Downy / Pubescent Oak	*Quercus pubescens*	41.9	36.1	34.6	30.0	32.2	41.9
	Gall Oak	*Quercus infectoria*	21.8	21.6	21.5	15.8	20.6	21.8
	Pedunculate / English Oak	*Quercus robur*	16.3	18.0	17.8	16.2	15.1	16.3
	Kermes Oak	*Quercus coccifera*	14.4	17.4	17.3	17.8	18.9	14.4
	Hungarian / Italian Oak	*Quercus frainetto*	25.6	16.8	17.9	18.7	20.2	25.6
	Oriental Hornbeam	*Carpinus orientalis*	30.1	27.9	20.2	20.9	19.3	30.1
	European Hornbeam	*Carpinus betulus*	31.4	18.3	17.6	24.5	21.4	31.4
	Anatolian Chestnut	*Castanea sativa*	27.1	24.3	25.4	24.3	24.9	27.1
	Other Oak Species		24.9	22.6	17.8	14.5	17.3	24.9
	Other Broadleaved Species		24.3	22.8	23.1	22.3	23.6	24.3
	Broadleaved Total		27.1	23.0	22.1	21.0	21.4	27.1
Coniferous Species (Pinales)	Calabrian Pine	*Pinus brutia*	21.6	22.6	23.2	20.8	20.0	21.6
	Crimean Pine	*Pinus nigra*	18.1	17.3	16.1	14.8	15.0	18.1
	Scotch Pine	*Pinus sylvestris*	20.1	20.8	18.7	19.4	19.4	20.1
	Greek Juniper	*Juniperus excelsa*	18.7	20.6	20.4	18.6	20.7	18.7
	Caucasian / Kazazdagi Fir	*Abies nordmanniana*	14.8	13.5	10.9	10.9	12.1	14.8
	Lebanon Cedar	*Cedrus libani*	16.5	13.7	14.0	14.3	17.8	16.5
	Eastern Spruce	*Picea orientalis*	16.8	17.2	18.5	16.6	14.5	16.8
	Syrian / Cilician Fir	*Abies cilicica*	15.2	17.6	20.2	21.4	17.0	15.2
	Stinking Juniper	*Juniperus foetidissima*	25.5	23.9	23.8	19.0	21.6	25.5
	Prickly Juniper	*Juniperus oxycedrus*	17.0	18.7	17.6	18.7	18.9	17.0
	Common Juniper	*Juniperus communis*	34.5	33.6	31.0	21.0	20.5	34.5
	Other Needled Species		21.9	14.0	11.8	11.9	11.9	21.9
	Needled Total		19.5	19.8	19.3	17.8	17.8	19.5
	Gross Total		**22.4**	**20.9**	**20.3**	**19.0**	**19.2**	**22.4**

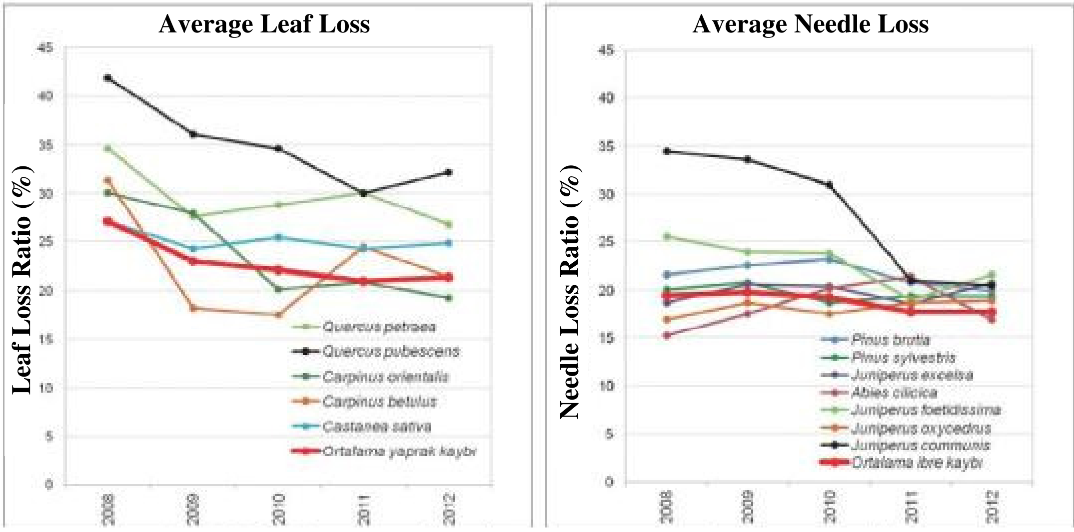


Figure 39. Changes of leaf/needle loss ratios according to the tree species

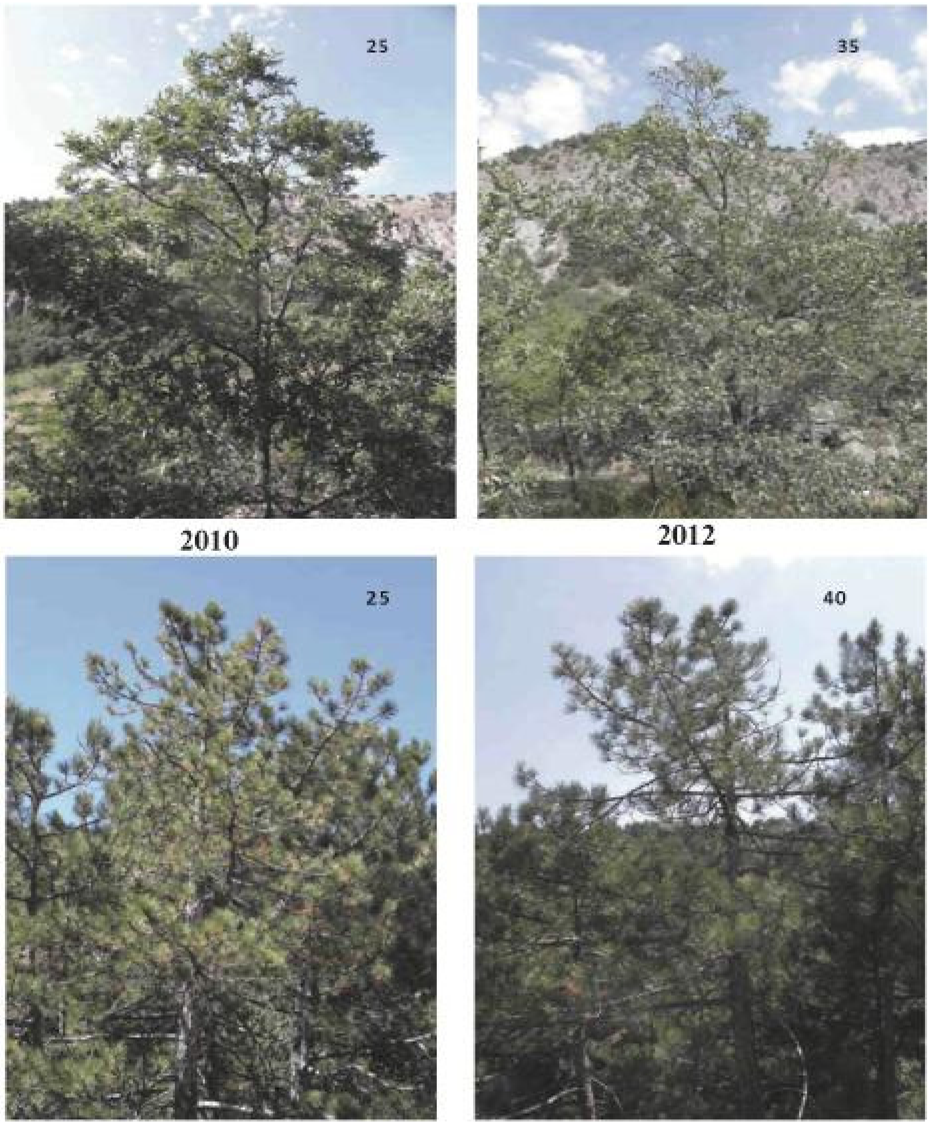


Figure 40. Crown states of Pubescent Oak (*Quercus pubescens*) in the observation site No. 1476, and of Crimean Pine (*Pinus nigra*) in Observation site No. 1031, in the years 2010 and 2012

Drying-outs seen Syrian/Cilician Fir (*Abies cilicica*) trees in Mersin

When the coniferous species is considered, it is noteworthy that needle losses in generally higher I n Juniper species. Common Juniper (*Juniperus communis*) is the most damaged coniferous species, with a needle lost ratio of over 30% between 2008-2010. In Common Juniper, despite some 10% reduction was observed in the needle loss ratios in the years 2011 and 2012 in this species, it is among the coniferous species with the highest loss ratios in these years. StinkingJuniper (*Juniperus foetidissima*) species is the second most-damaged coniferous species between 2008-2010. Although the health status of stinking juniper trees improved in 2011 to some extent, it was the species with second most needle loss in 2012 with a loss ratio of 21.6%. As for Greek Juniper (*Juniperus excelsa*) species, it was one of the few species (Cedar, Syrian Fir and Prickly Juniper) with an increasing needle loss compared to 2008, and it was the second species with the most needle loss in 2012, with a loss ratio of 20.7%. In Calabrian Pine, which had the highest number of assessed trees, the needle loss ratios during the 5-year evaluation period varied between 20.0% and 23.2%, which caused it to rank among the coniferous species with the highest needle loss (Table 5 and Figure 39).

Monitoring of the health status of forest ecosystems allows at the same time for the spatial assessment of the forests. For this purpose, while crown assessments are carried out in Level I observation sites, the average leave/needle loss amounts of the trees are also calculated and shown on a map (Figures 41-46). According to these maps, it can be seen that the forest areas where forest health is poor remained almost the same between the years 2008-2012 in our country. Leaf/needle losses in forest areas especially in the north of Thrace, in Central and Eastern Black Sea Regions and in Central Anatolia Region are over the general average of Turkey for all the years during which monitoring studies were conducted.

In West and Central Black Sea Regions, health status of forests was poor in 2008, and leaf/needle loss ratio decreased continuously in the following years, and thus, now certain improvement is noticed in the health status of forests. In Eastern Black Sea Region, overall forest health has improved over time except the year 2010. It is important to note that leaf/needle losses demonstrated an overall decline during the 5-year period, while health status of forests Marmara and Central Anatolia Regions started to worsen during recent years again after the initial improvement, and that health status of forests especially in the regions behind Black Sea is generally poor (Figure 41-46).

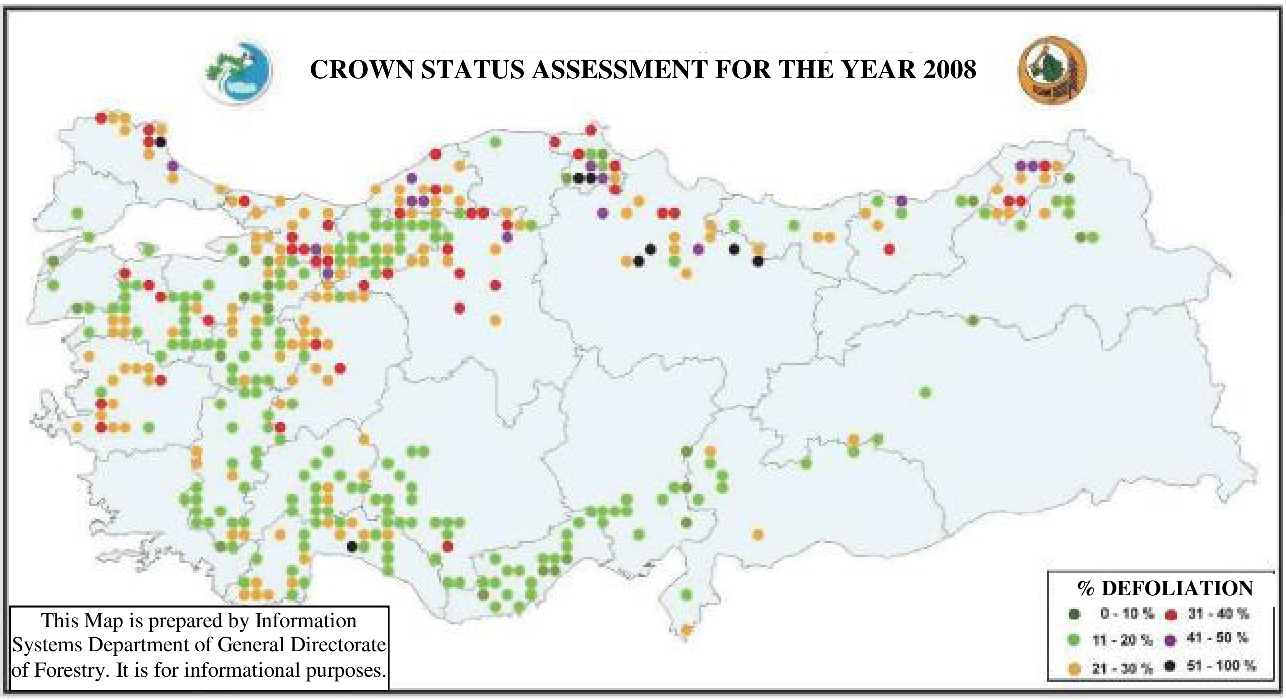


Figure 41. Average leave/needle losses in Level I observation sites in 2008

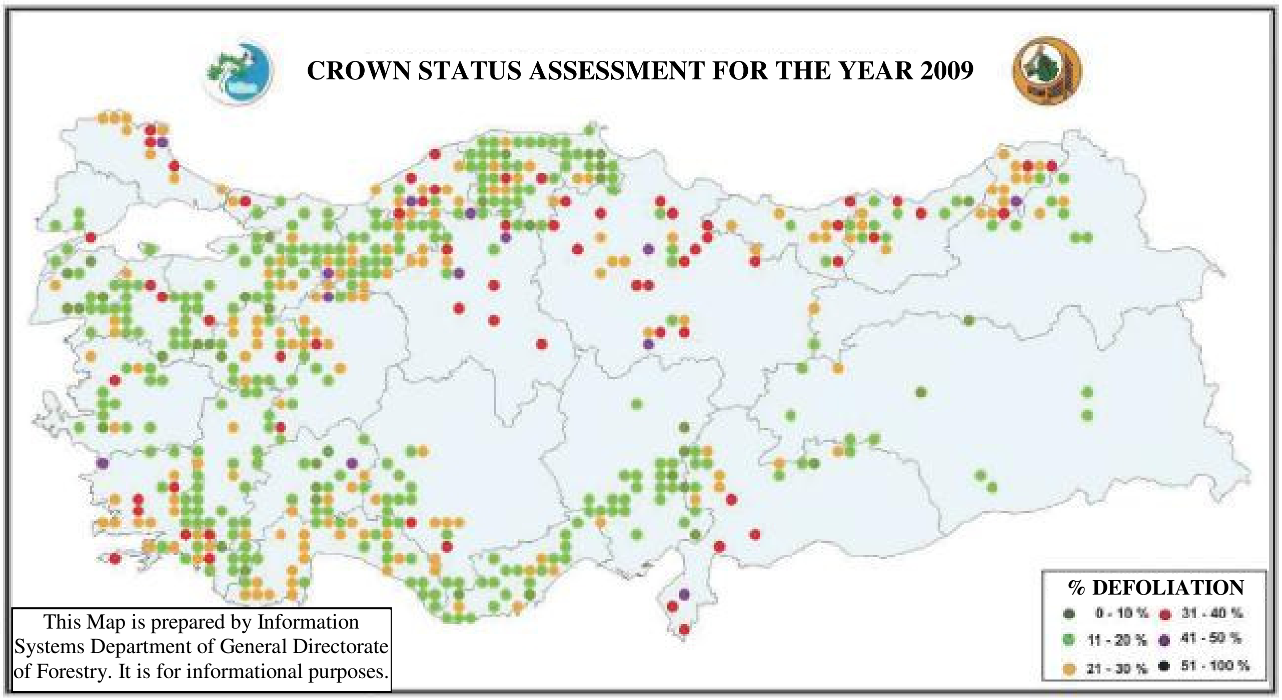


Figure 42. Average leave/needle losses in Level I observation sites in 2009

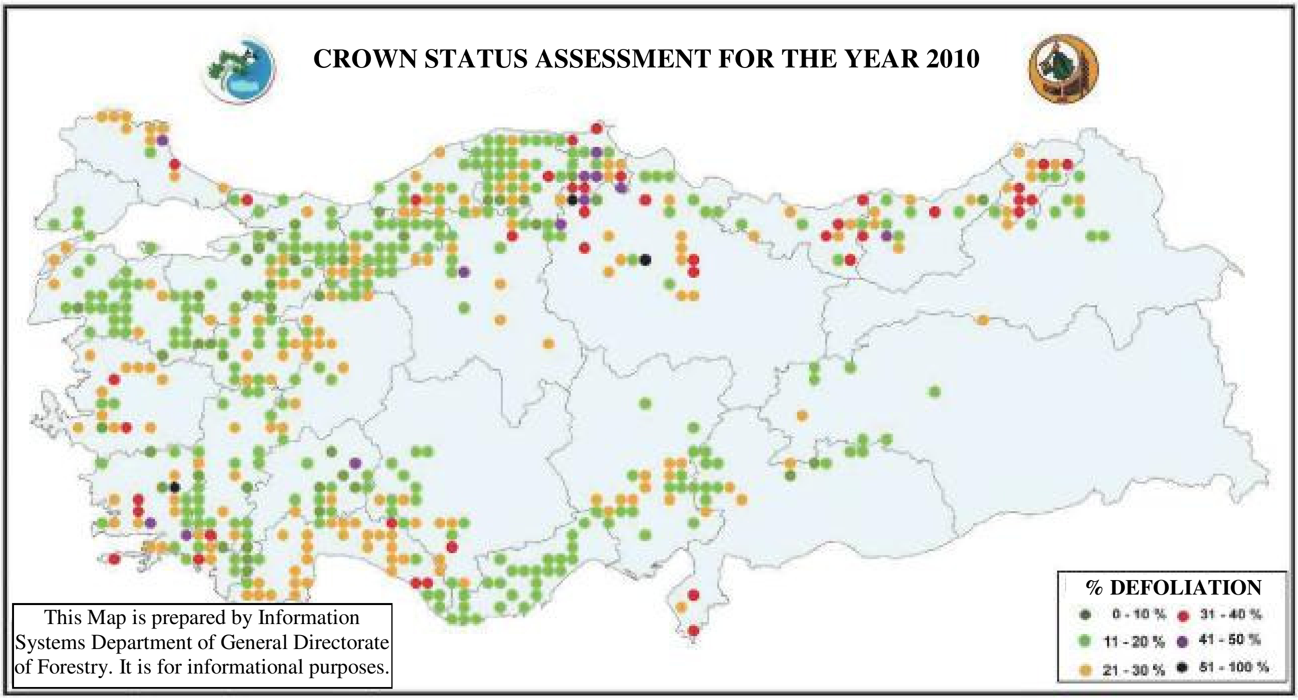


Figure 43. Average leave/needle losses in Level I observation sites in 2010

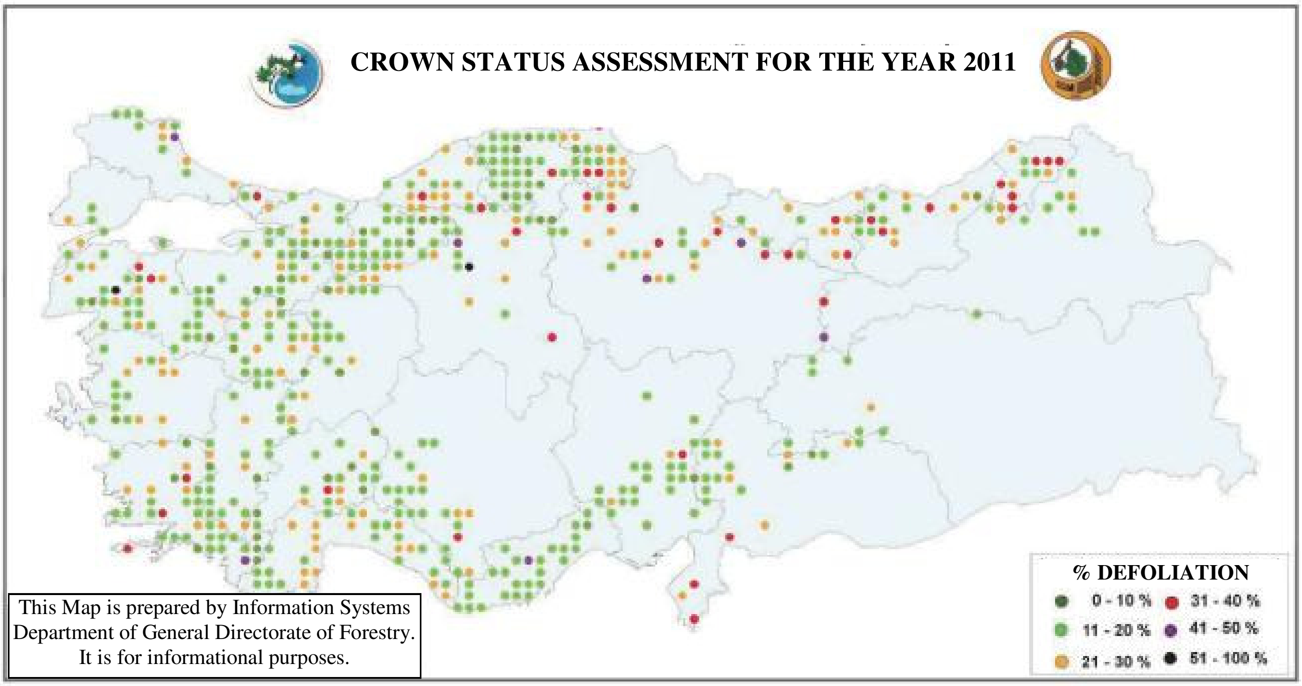


Figure 44. Average leave/needle losses in Level I observation sites in 2011

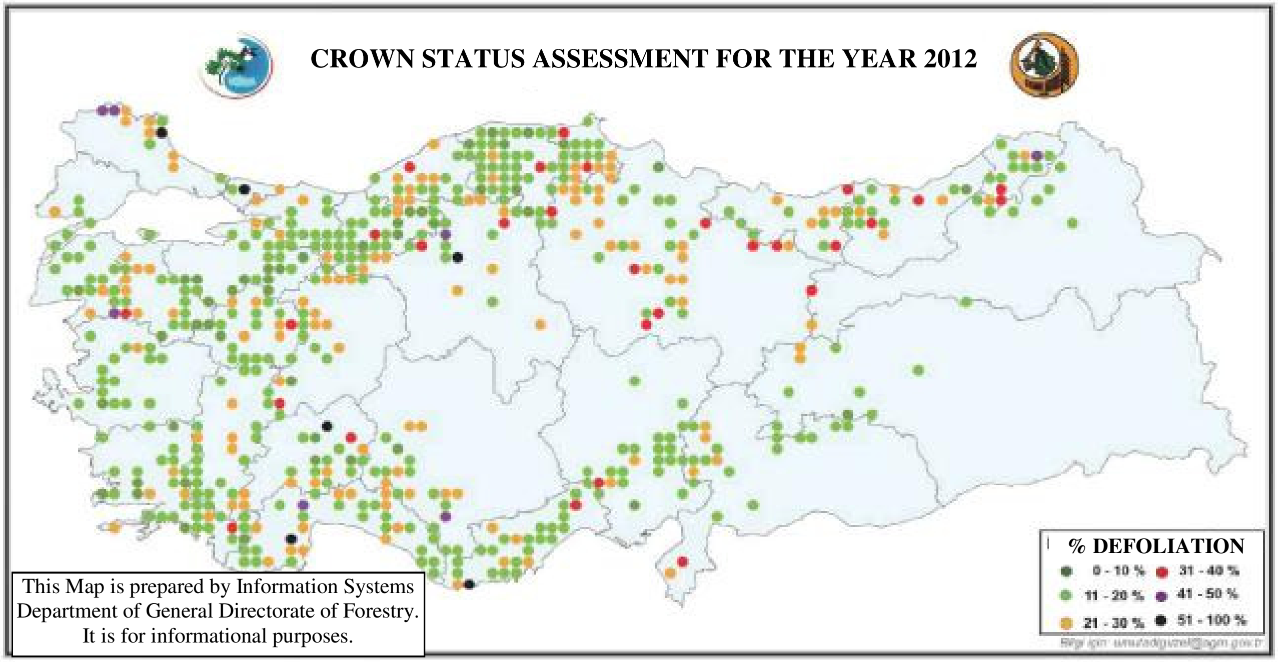


Figure 44. Average leave/needle losses in Level I observation sites in 2012

Crimean Pine / Larch trees in forest boundaries, Denizli

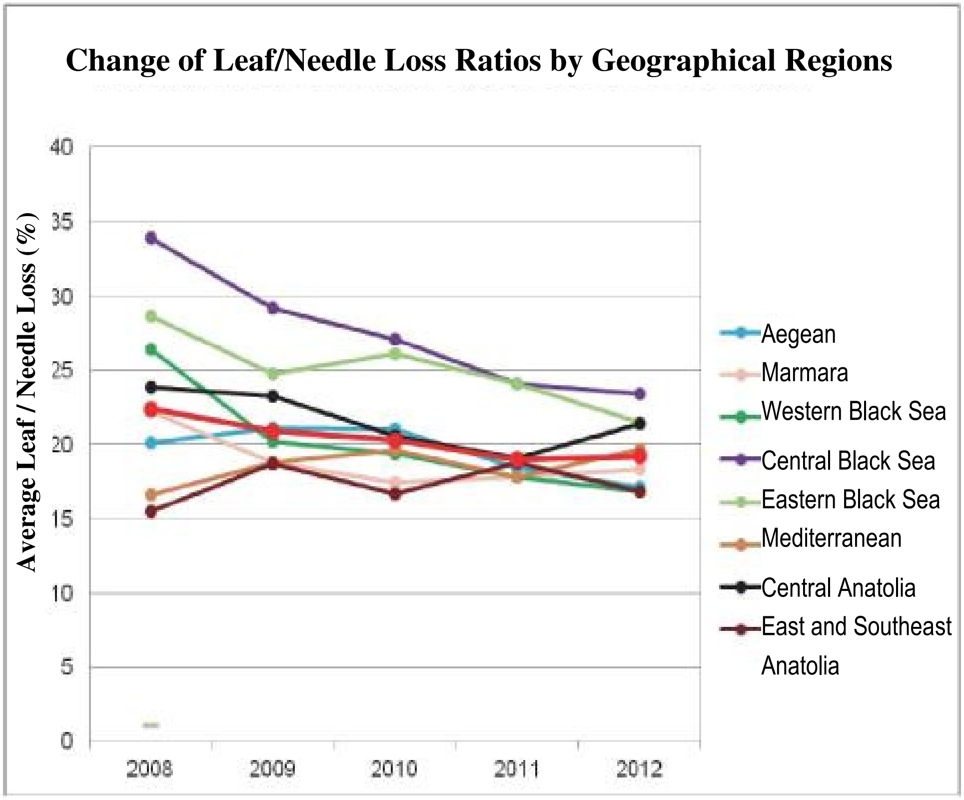
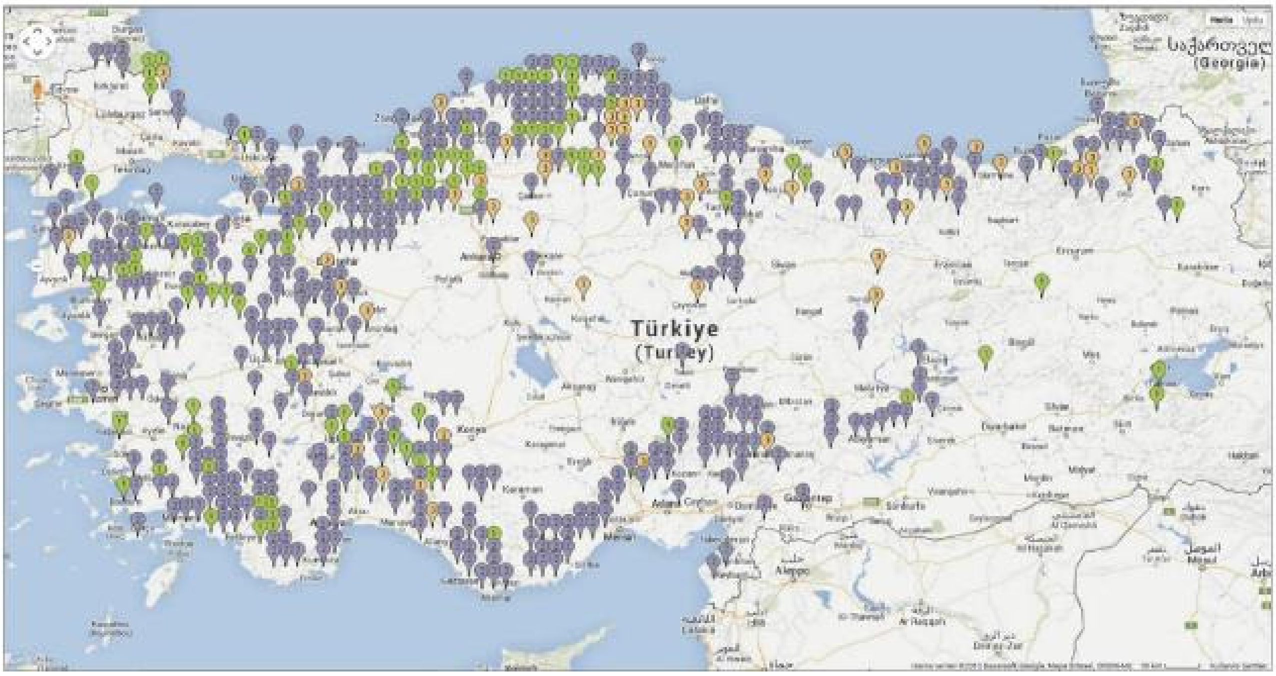


Figure 46. Change of average leave/needle loss ratios in geographical regions by the year



The animated design in the Web environment showing average defoliations and observation site data in Level I observation sites

When an assessment is made according to Regional Forestry Directorates, it can be seen that average leaf/needle losses were over 30% in 2008 in Amasya, Artvin, Istanbul, Ankara and Istanbul Regional Directorates.

During the following years, leave/needle losses constantly decreased in most of the Regional Directorates of Forestry, and in Istanbul Directorate of Forestry fell below 25% in 2012 (Figure 47 and Table 6). Health status of forests was poor around Izmir and Mugla provinces during the 2008-2010 period, and Hatay province between the years 2009-2012 (Figure 41-45).

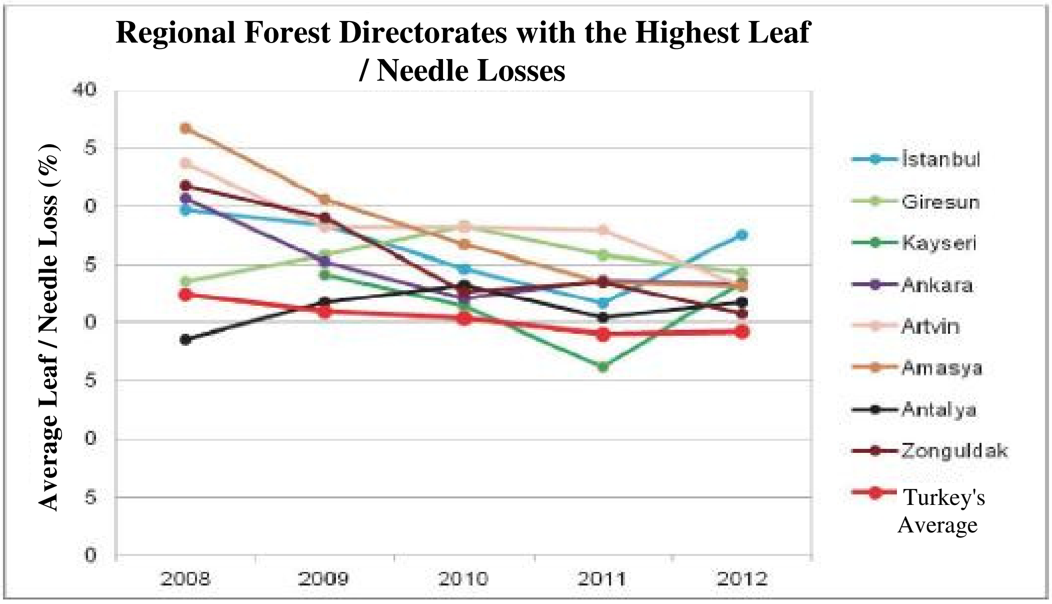


Figure 47. Annual changes in Regional Forestry Directorates with the higher average leaf/needle loss

A general view of the Oak forest in Demirköy

Table 6. Annual change of average leaf/needle losses in Regional Directorates of Forestry (in %)

Regional Directorates of Forestry	2008	2009	2010	2011	2012
Istanbul	29.7	28.4	24.6	21.6	27.5
Giresun	23.5	25.8	28.2	25.8	24.3
Kayseri	-	24.1	21.3	16.1	23.5
Ankara	30.7	25.2	22.0	23.6	23.3
Artvin	33.6	28.2	28.2	27.9	23.1
Amasya	36.7	30.6	26.7	23.4	23.1
Antalya	18.5	21.7	23.2	20.3	21.7
Zonguldak	31.8	29.0	22.6	23.4	20.7
Eskisehir	26.4	24.7	19.4	15.4	20.5
Trabzon	22.5	22.1	24.2	21.4	20.4
Mersin	13.6	18.1	19.0	15.7	20.0
Kahramanmaras	19.5	26.8	22.2	21.5	19.9
Erzurum	14.7	18.4	18.6	19.9	18.9
Konya	15.3	19.6	19.9	18.0	18.8
Kütahya	18.3	21.3	19.1	18.4	18.7
Isparta	17.9	15.6	12.5	14.6	18.3
Adapazari	28.7	15.7	15.0	14.2	18.3
Denizli	17.5	16.6	17.9	17.3	18.1
Balikesir	18.7	16.6	16.1	19.2	18.1
Adana	13.3	13.1	20.6	17.1	17.1
Elazig	16.4	17.8	16.3	16.4	16.3
Kastamonu	31.8	17.1	20.0	17.5	16.2
Izmir	25.8	18.2	23.2	19.1	16.1
Mugla	-	25.2	23.2	18.9	15.9
Bolu	20.1	20.6	16.3	14.8	15.5
Sanliurfa	17.3	19.7	13.7	18.7	14.7
Bursa	16.4	17.2	15.3	14.8	10.2
Turkey's average	**22.4**	**20.9**	**20.3**	**19.0**	**19.2**

A general view from Syrian Cedar forests in Elmali, Antalya

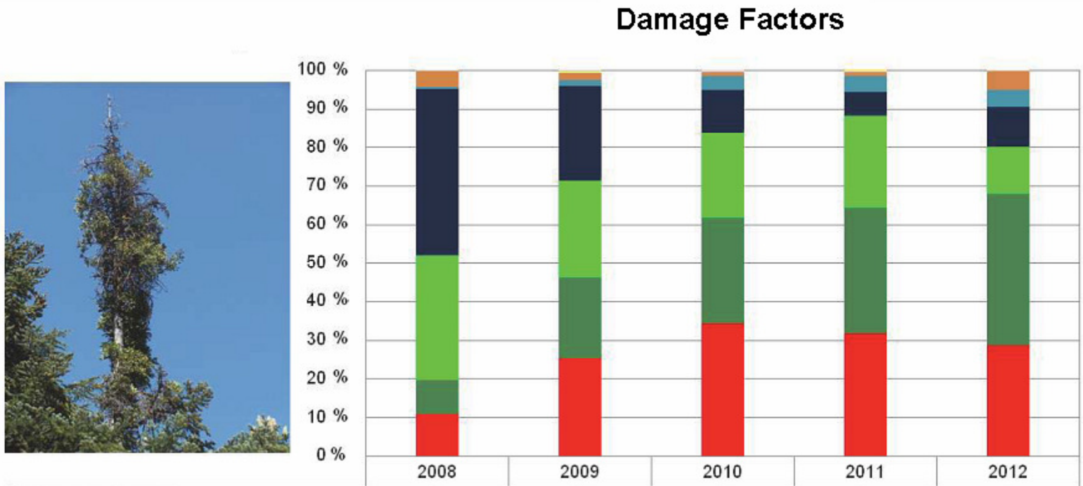
6. DAMAGE FACTORS DETERMINED IN LEVEL I OBSERVATION SITES IN TURKEY’S FORESTS

Within the scope of the Forest Ecosystem Monitoring Program, annual data is obtained on the factors which cause damage to trees. For this purpose, biotic factors such as insects, fungi, wild animals and grazing as well as human influences are recorded at the time when the crown condition assessment was made in the trees in the observation sites, in addition to abiotic factors such as wind, storms, frost, nutrient deficiency or excess, atmospheric pollutants and fire. Most of these damage factors are revealed by the help of the symptoms determined on the trees during the observations, mostly conducted during the summer months. Depending on the symptoms, it is even possible to determine which insects and fungi species especially cause more damage.

During the early years of the field studies in Turkey, certain drawbacks were experienced in the diagnosis of damage factors due to lack of experience of the field teams, but attempts have been made during the following years to overcome these problems through training.

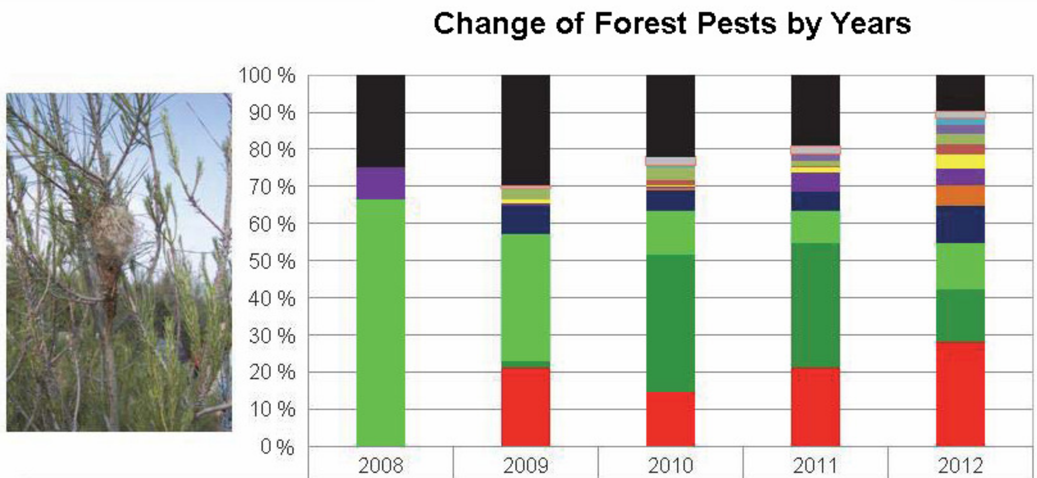
However, it is still impossible to determine clearly which factor is dominant on the deteriorated health condition of the trees when the health status is poor. This failure manifests itself in the example of approximately thousand trees with a deteriorated health status between the years 2009-2012, for which damage factors could not be determined precisely. Insects, abiotic factors, human, and fungi species are other prominent damage factors in the forests of Turkey (Figure 48).

The most frequently observed symptoms in damaged trees in Level I observation sites in Turkey are associated with insects. Symptoms associated with insect damage was identified in 25% to 35% of the damaged trees during the years 2009-2012 (Figure 46). Damage is especially caused by pine processionary moth (*Thaumetopoeapityocampav T. wilkinsoni*) in Calabrian Pine, and by gypsy moth (*Lymantaria dispar*) and *green oak moth* (*Tortrixvirid valve*) in Oak species. In addition, among the bark beetles showing a secondary harmful properties in coniferous species, common pine shoot beetle (*Tomicuspiniperda*) and Six-spined engraver beetle (Ipssexdentatus) has been frequently noted (Figure 49).



	2008	2009	2010	2011	2012
Atmospheric pollutants	2	10	1	0	0
Fire	2	11	8	9	0
Wild animals and grazing	0	0	3	4	3
Direct effects of human	86	62	37	35	125
Fungi	12	58	133	144	112
Abiotic factors	902	869	414	217	257
Other causes of damage	680	885	811	836	313
Examined but not identified	182	736	1011	1148	991
Insects	231	894	1271	1115	725

Figure 48. Biotic and abiotic damage factors determined in Level I observation sites during the years 2008-2012



	2008	2009	2010	2011	2012
Other Pests	3	153	315	264	91
Cryphonectria parasitica		5	34	28	16
Armillaria mellea			8	6	18
Rhyacionia buoliana			1	20	24
Agelastica alni		15	48	22	24
Rhynchaenus fagi			19	2	27
Ips sexdentatus		4	6	22	33
Lophodermium pini	1	4	6	69	42
Tomicus piniperda			10	3	52
Tortrix viridana		39	77	69	94
Lymantria dispar	8	176	171	124	115
Thaumetopoea pityocampa		10	527	461	133
Viscum album		109	212	295	261

Figure 49. Biotic pests mostly observed in Level I observation sites between the years 2008-2012

The most frequently encountered pest after insects is the Mistletoe (Viscum album), which is semi-parasitic plant (Figure 50). Mistletoe was even the mostly observed pest in the trees assessed in 2012, and it was mainly found in softwood species like fir and pine species.

Figure 50. Mistleto pest in Nordmann Fir and Syrian Fir

Lophodermium pini, observed in pine species and causing burns in needles, is the most common type among the fungal factors. Also, presence of *Armillaria mellea* species which causes root rotting in oaks, and *Cryphonectria parasitica* species which causes Chestnut Cancer has also been identified (Figure 49). During recent years, failure to observe the symptoms indicating presence of *Phytophthora* species, which causes significant diseases in Chestnut and Oak trees, is attributed to the difficulties in diagnosis of these species rather than to its absence in the observation site. Indeed, in a study conducted in oak forests in Turkey by Balci and Halmschlag (2003), species *Phytophthora cinnamomi, Phytophthora citricola, Phytophthora cryptogea, Phytophthora gonapodyides, and Phytophthora quercina* were found along with two other Phytophthora species that were not identified. Of these, is considered to be closely related especially with oak mortality in Thrace. *Phytophthora ramorum*, one of the dangerous types of *Phytophthora* species, has been recorded in our country.

As the spores of these species can also spread through the air, and as it was detected in Forest Rose Lake in Greece (Tsopelas et al., 2011), it is necessary to be careful abut these species. In fact, tree deaths were seen in boxwood forests in the Eastern Black Sea Regions under the influence of *Cylindrocladium buxicola* and *Volutella buxi* fungi, which are thought to come from the neighboring countries. Similarly, presence of Western Conifer Seed Bug (*Leptoglossus occidentalis)* was identified in 2012, which is a non-native insect species of our country causing damages in Stone Pine cones. *Chalara fraxinea* species, which causes serious diseases in European Ash forests, is also an important threat for our country and although it has not recorded in our country yet, its presence should constantly be checked in forests particularly close to the borders and quarantine practices should be applied.

Studies carried out in Level I observation site for the determination of damage factors may also provide valuable information regarding whether insect and fungal factors have become epidemic or whether or not exotic species have entered our country.

However, the deficiencies in the diagnosis of disease factors (fungal, viral, bacterial) should be addressed with training, and with the inclusion of experts of insect and disease factors in the teams. Although insect and fungal agents are mostly considered as the leading factors in the evaluation of the health status of forests, only 25% to 30% of the detected damage is directly related with insects.

Moreover, most of insect and fungal agents are generally of subsidiary factors in the health loss of the trees. These pests usually cause epidemic and even tree deaths after the trees have fallen weak due to such reasons as drought and lack of nutrients. Therefore, it is necessary to assess primary factors whose symptoms can not be observed exactly during the field observations (Figure 51).

Figure 51. Various damage symptoms a) frost damage, b) lightning damage, c) toxic damage of boron element, d) thrown by wind e) fungi, f) Western Conifer Seed Bug

Elmali, Antalya

One of the most important factors affecting the health of forest trees is the climate. Climate effects have gained more importance during the last 10-15 years during which the problems of global warming and climate change have had more serious effects. Indeed, average leave/needle loss ratios of European forests leaf/needle loss ratios had a peak in the years 2004 and 2005, and health status of the trees has improved in subsequent years. It is reported that especially European Beech was influenced from the heat and drought in Central Europe in 2003 (Fischer et al., 2009). A hot and dry period was also experienced in Turkey during the years 2007 and 2008 (Table 7). Even so, the year 2008 had the lowest rainfall of the last 50 years, with an annual total annual of 504.1 mm. Although 2009 was a warm year, during which the highest rainfall of the last 50 years occurred. Total annual precipitation values during 2011 and 2012 years were higher than the long term average (MGM, 2013). It is not a correct approach to assess health status of forests by looking at total annual rainfalls and average temperatures.

Health statuses of forests are directly affected from the rainfalls and temperatures during the vegetation period. Indeed, in 2008, spring and summer rainfalls were well below the long term average (Figure 52). In addition, summer temperatures were 1.3°C higher than the long-term average in 2008 (Figure 53). The drought conditions in 2008 in our country must have had an effect on the high leave/needle losses in 2008, and on the improvement in the health statuses of the trees during the later years. The year 2010 was recorded as the warmest year in our country and in the world as well. However, the health statuses of forest trees were not affected seriously in 2010, which was about 2°C warmer than the long-term average. This situation must have originated from the fact that the total rainfalls and summer rainfalls were relatively higher in 2010. The reason for the increase in the amount of leave/needle loss observed in broadleaved tree species in 2012 could be the summer drought observed during that year (Figures 52 and 53).

Table 7. Total annual rainfall and annual average temperature values in Turkey by years, with the separate values of the last 6 years (MGM, 2013)

Years	Annual Average Temperature (C°)	Annual Total Rainfall (mm)
1971-2000	13,2	642,8
2007	13,8	616,2
2008	13,6	504,1
2009	13,7	815,7
2010	15,2	721,6
2011	13,2	654,7
2012	14,2	745,0

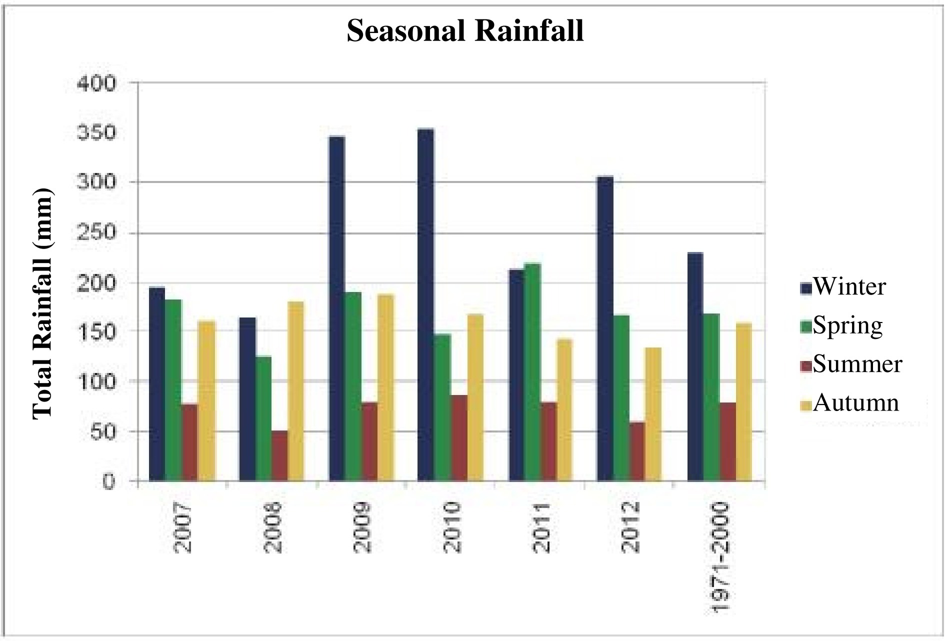


Figure 52. Comparison of seasonal rainfalls observed during the period 2007-2012 with the long-term averages (Compiled from MGM, 2008; MGM, 2009; MGM, 2010; MGM, 2011; MGM, 2012 and MGM, 2013)

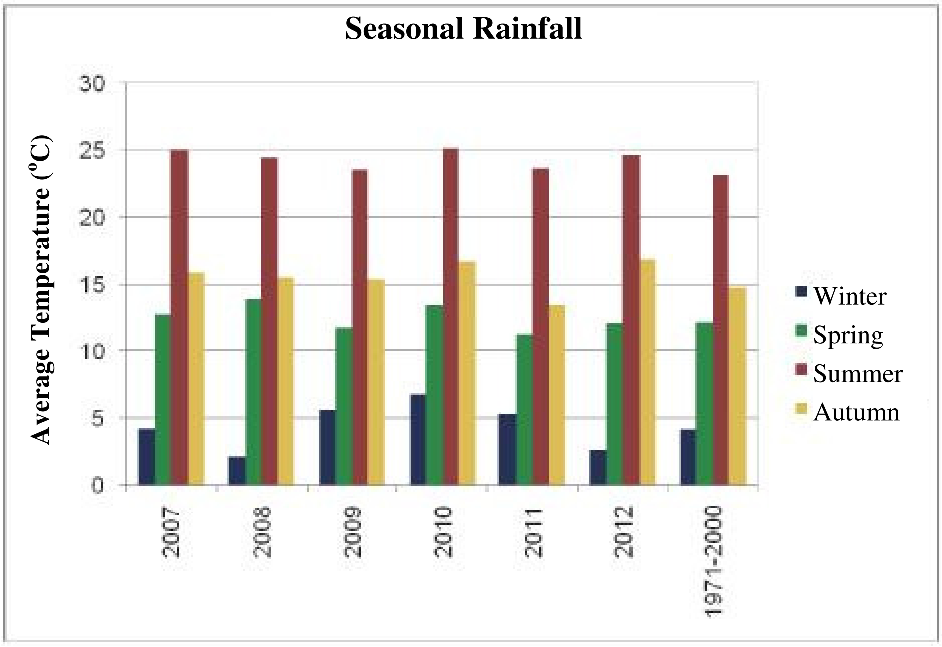


Figure 53. Comparison of seasonal temperatures observed during the period 2007-2012 with the long-term averages (Compiled from MGM, 2008; MGM, 2009; MGM, 2010; MGM, 2011; MGM, 2012 and MGM, 2013)

Rainfalls and temperatures are highly variable regionally as well. This variability can also be effective on the change of leaf/needle losses in the forests by geographic region and by Regional Directorate of Forestry. For example, summer rainfalls in Central Anatolia, Thrace and Mediterranean Regions were recorded below the normal values in 2012 (MGM, 2013). At the same time, leave/needle losses in these Regions showed an increase compared to 2011. However, the relation between meteorological phenomena and leave/needle losses should be investigated by detailed studies. Nevertheless, it is obvious that long-term monitoring of leaf/needle losses will also help to enlighten the effects of climate change on forests.

Another factor leading to the deterioration of the health status of forests is air pollution. As mentioned previously, the ICP Forests is a program that was basically set up to examine the effects of air pollution on forests. Studies related with the impacts of air pollution on forests in Turkey intensified during 1990s (Kantarci, 2001; Kantarci and Karaöz, 2001; Makineci, 1997; Tolunay and Makineci, 2001; Tolunay 2003a; Tolunay, 2003b). However, these studies ceased during 2000s.

The research studies conducted to determine sulfur concentration in the needles and leaves revealed the negative effects of air pollution on the forest areas surrounding thermal power plants or industrial areas. Indeed, the list published by Barrett (2004) containing 200 thermal power plants in Europe with the highest SO_2 emissions includes 6 (six) thermal power plants from Turkey. The reason of high leave/needle losses in the forest areas surrounding especially the thermal power plants in Mugla and surrounding the Iskenderun industrial zone, in south of Turkey could be air pollution (Figure 54).

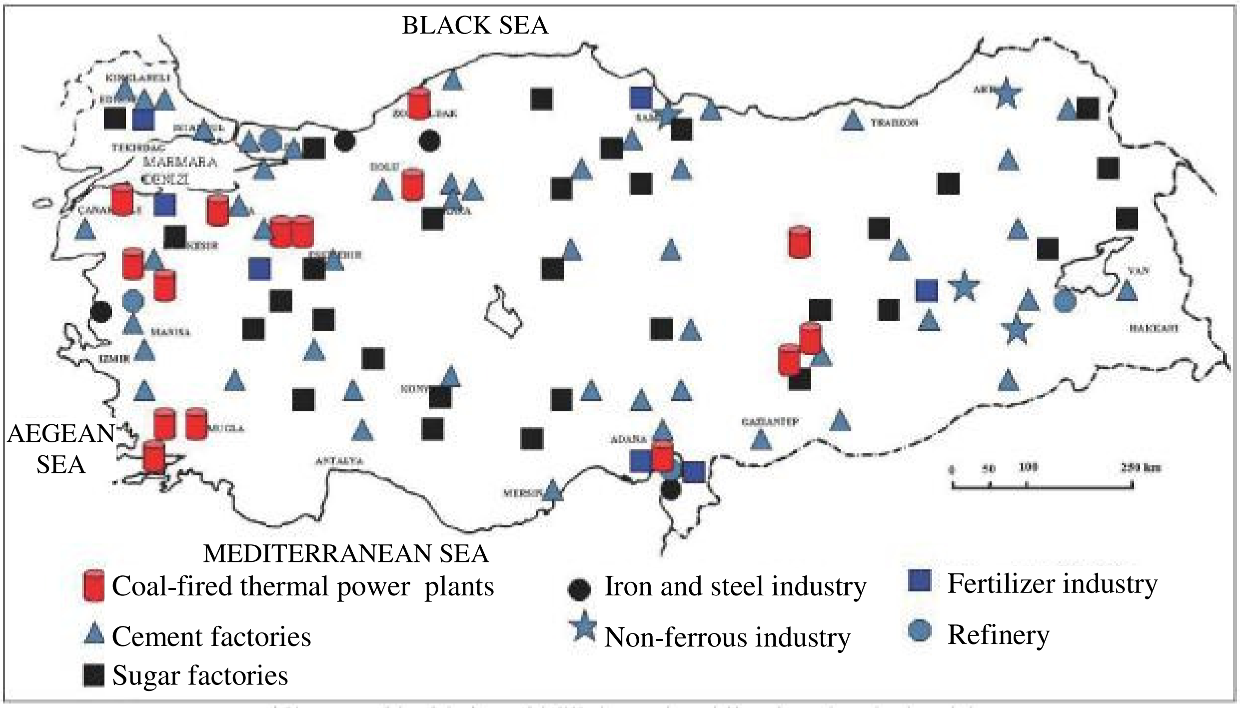


Figure 54. Industrial facilities that could lead to air pollution in Turkey
(Prepared by Tolunay et al. (2010) with modification from Hunter, 2005 and Say, 2006)

In Turkey, studies on wet and dry deposition were intensified in the 1990s. These studies were carried out mostly in cities or in the immediate vicinity of the cities; it was especially determined that sulfate and nitrate concentrations were high in the precipitations in and around Istanbul, and that as Calcium is also high, it neutralizes the pH values of the rainfalls (Gulsoy et al., 1999; Akkoyunlu and Tayanc, 2003). High sulfate and nitrate concentrations in the rainfalls in and around Istanbul is known to be originating from Balkans and Eastern Europe, apart from the residential heating source (Okay et al., 2002; Akkoyunlu and Tayanc, 2003). In fact, it is noteworthy to see that the trees in the northern region of Turkey have high leave/needle losses (Figures 41 to 45).

Also, wet deposition measurements were made during 1990s in EMEP (European Monitoring and Evaluation Program) stations. Tuncel (2003) reports high sulfate, nitrate and ammonium values in in Amasra, Menemen and Antalya Stations respectively at the Black Sea, Aegean and Mediterranean shores, which are among the 5 EMEP stations in different regions of Turkey. It is reported that ion concentrations in Ankara station in Central Anatolia and in Uludag station, which is relatively far from the shore, are lower (Tuncel, 2003). This situation was interpreted as such that Turkey's coastal regions can be considered very polluted and inland terrestrial regions are less affected by the pollutant carry over (Tuncel, 2003).

Along with these studies, researches were also made related to the pH value of the rainfall waters in forests. The pH values of the rains brought by air masses from the Black Sea coming over Rumeli Lighthouse and Bahcekoy in the north of Istanbul were found to be 4.2 – 5,7 (Kantarci, 1986). During the measurements made in the Belgrade Forest in the same locality, pH value of the rains under the Oak forests was found to be 3.4 – 6.8, with lower pH values of the rain precipitating in winter months (Cepel et al., 1994). Apart from rainwater reactions, Kantarci (1992) separately measured snow reactions as well. According to the said study, at Bolu-Aladag location between 900-2000 m altitudes pH was 3.4 – 6.0; at Kocaeli Samanli Mountain pH was 4.8 – 6.0; and at altitudes between 1600-1800 m at Bursa-Uludag pH was 4.3 - 6.1. Zengin (1997) conducted measurements of pH and various ions in under-canopy rains, trunk waters and rainfall waters in different species in Izmit and Kerpe regions. According to the results, it was determined in brief that rainfalls are more acidic in Kerpe region, that pH values fall in the winter months, that under-canopy rains in coniferous forests have lower pH values compared to broadleaved forest, and that most of the rains in Kerpe region have pH values lower than 5.6.

As can be seen from the above, although studies have not been made during recent years in our country, it has been previously demonstrated that air pollution and acid precipitation have occurred and that they have affected forest ecosystems. In addition, the effects of climate change are being felt in our country, and it is reported that our country will be among the countries most affected by climate change in the years ahead (IPCC, 2007). However, it is quite difficult to determine the effects of air pollution and climate change on the forests by assessments made in Level I observation sites. For example, the reson of the reality that leaf/needle losses are high in general in Thrace, Central and Eastern Black Sea, and Central Anatolia Regions could be the climate, long-range air pollution, or the combined effect of both. Perhaps another factor we have not recognized yet could have a negative impact on the health status of the forests. In order that the results obtained from the Level I observation sites can be interpreted in an accurate manner and healthily, Level II mechanism should be employed, which requires intensive monitoring studies and which allows for examining cause-and-effect relationships in ICP Forests program. Therefore, studies should be initiated as soon as possible in the sites selected among Level II observation sites.

Dead trees, which are of great importance both for as a carbon pool and for biological diversity; Belgrade Forest, Istanbul

Mixed stands of Syrian Cedar, Greek Juniper and Turkey Oak, Egirdir, Isparta

7. STUDIES MADE WITHIN THE SCOPE OF LEVEL II PROGRAM IN TURKEY

Plans are being prepared to set up approximately 50 Level II observation sites in Turkey. These Level II observation sites will be established on a forest area Spread over more than 400 thousand hectares involving more important tree species (Table 8 and Figure 55). Within the scope of the Program, potential Level II locations have been determined, and installation a total of 50 observation sites has been achieved (Table 9). However, it is quite difficult to perform all the fieldworks and laboratory analysis required to understand the contemplated ecosystem processes in all Level II observation sites, and it requires serious financing.

For this reason, intensive studies are carried out in 15 of the 50 Level II observation sites that have been set up in our country (Figure 56 and Table 9). When the Forest Ecosystem Monitoring Program began for the first time in 2006, national experts to be responsible for assessment issues were identified, and the designated experts were provided with domestic and overseas trainings. After that, regional responsible staff were appointed. Assessment and supervision manuals for the assessment subjects were prepared by these experts using the ICP Forests Program manuals as the reference. Since 2007, studies have been continued in the intensive Level II observation sites. However, in some intensive monitoring studies, it is necessary to analyze the samples (rain water, soil, leaves / needles, soil solution, air pollutants, litters) collected from the field in laboratories.

For this purpose, a Soil and Ecology Laboratory was founded in the Aegean Forestry Research Institute, and currently, quality control and assurance activities for the analysis to be made in the laboratory are continued; analyses will be started during 2013 (Figure 57). Thus, studies on the subjects requiring laboratory works could not be started for this reason. As for the subjects independent from the laboratory (such as crown condition, vegetation and biodiversity, phenological observations and monitoring of Ozone damage), assessment studies have been continuing for about 4 years. In addition, the procurement of meteorological stations to be set up in the intensive Level II observation sites was realized by GDF, and these stations will be installed during 2013 through the cooperation with the General Directorate of Meteorology.

Table 8. Distribution of tree species in our forest areas and the number of Level II observation sites as of 2012

Tree species		Forest area			Potential Level II Sites	
		Normal	**Damaged**	**Total**	**Standard**	**Intensive**
Calabrian Pine	*Pinus brutia*	3,207,914	2,646,759	5,854,673	13	3
Oak Species	*Quercus* sp.	2,105,937	3,046,624	5,152,561	13	2
Crimean Pine	*Pinus nigra*	2,580,193	2,112,867	4,693,060	8	2
Oriental Beech	*Fagus orientalis*	1,621,257	340,403	1,961,660	5	2
Scotch Pine	*Pinus sylvestris*	751,060	728,588	1,479,648	3	2
Fir Species	*Abies* sp.	406,989	263,400	670,389	2	1
Juniper Species	*Juniperus* sp.	91,234 4	84,081	575,315	2	1
Lebanon Cedar	*Cedrus libani*	220,328	243,193	463,521	2	1
Eastern Spruce	*Picea orientalis*	230,212	104,260	334,472	2	1
Alder	*Alnus glutinosa*	99,984	41,134	141,118		
Sweet Chestnut	*Castanea sativa*	75,249	35,795	111,044		
Stone Pine	*Pinus pinea*	60,889	28,139	89,028		
Hornbeam Species	*Carpinus* sp.	15,235	4,727	19,962		
Lime Species	*Tilia* sp.	9,577	1,946	11,523		
Ash Species	*Fraxinus* sp.	8,495	948	9,443		
Poplar	*Populus* sp.	1,871	4,676	6,547		
Eucalyptus Species	*Eucaliptus* sp.	2,398	130	2,528		
Other Species	Other species	69,846	31,796	101,642		
Total	Total	11,558,668	10,119,466	21,678,134	50	15

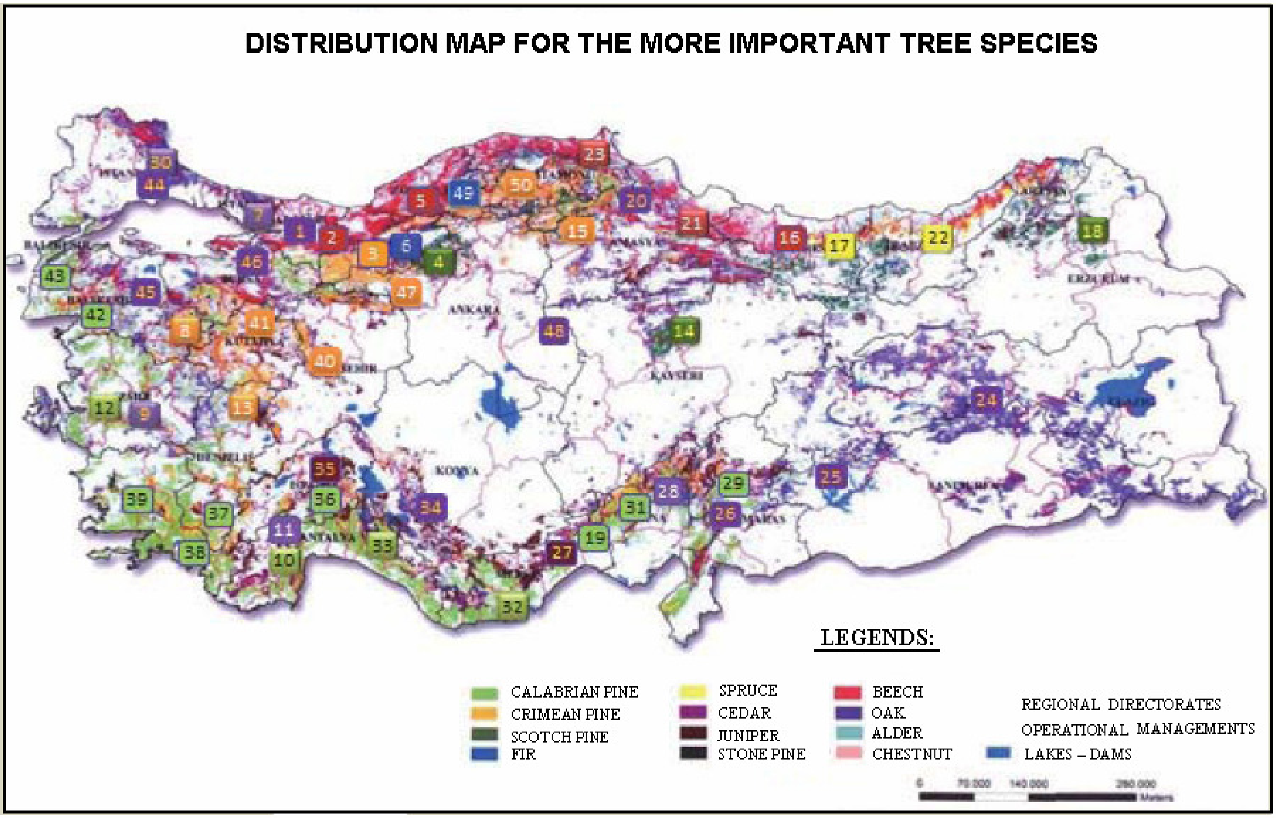


Figure 55. Locations of Level II observation sites with completed installation

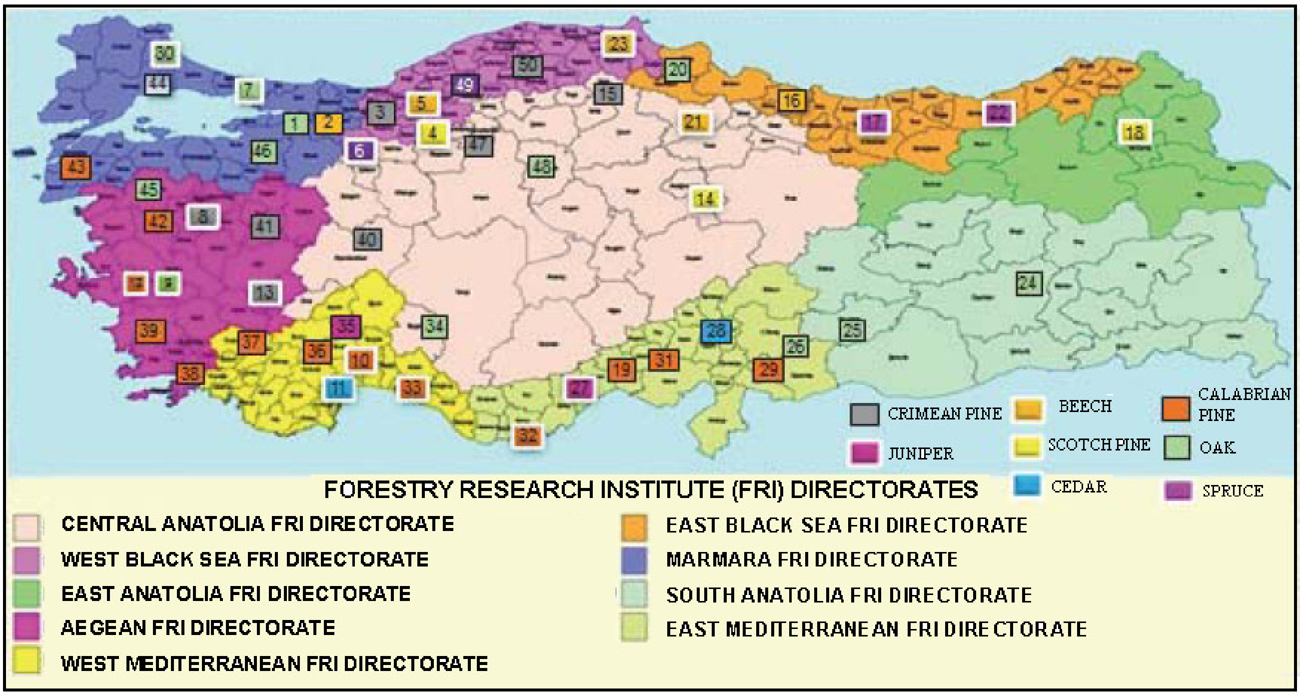


Figure 55/A. Locations of Level II Observation sites by Forestry Research Institutes

Table 9. Level II Observation sites by tree species and monitoring intensity

Tree Species	Observation site	Regional Directorate	Observation site, attribute
Calabrian Pine	10	Antalya	Intensive
Calabrian Pine	12	Izmir	Intensive
Calabrian Pine	19	Mersin	Standard
Calabrian Pine	29	Kahramanmaras	Intensive
Calabrian Pine	31	Adana	Standard
Calabrian Pine	32	Mersin	Standard
Calabrian Pine	33	Antalya	Standard
Calabrian Pine	36	Isparta	Standard
Calabrian Pine	37	Denizli	Standard
Calabrian Pine	38	Mugla	Standard
Calabrian Pine	39	Mugla	Standard
Calabrian Pine	42	Balikesir	Standard
Calabrian Pine	43	Balikesir	Standard
Oak (Gall – Turkey)	25	Sanliurfa	Standard
Oak (Sessile – Turkey - Hungarian)	20	Amasya	Standard
Oak (Sessile)	1	Adapazari	Standard
Oak (Sessile)	7	Istanbul	Standard
Oak (Turkey)	9	Izmir	Standard
Oak (Turkey- Gall)	24	Elazig	Standard
Oak (Gall)	26	Kahramanmaras	Standard
Oak (Turkey- Hungarian)	45	Balikesir	Standard
Oak (Pedunculate)	46	Bursa	Standard
Oak (Sessile)	30	Istanbul	Intensive
Oak (Turkey)	34	Konya	Intensive
Oak (Pedunculate- Sessile)	44	Istanbul	Standard
Oak (Turkey)	48	Ankara	Standard
Crimean Pine	3	Bolu	Standard
Crimean Pine	8	Balikesir	Intensive
Crimean Pine	13	Denizli	Standard
Crimean Pine	15	Amasya	Standard
Crimean Pine	40	Eskisehir	Standard
Crimean Pine	41	Kutahya	Standard
Crimean Pine	47	Ankara	Standard
Crimean Pine	50	Kastamonu	Intensive
Oriental Beech	2	Adapazari	Intensive
Oriental Beech	5	Zonguldak	Standard
Oriental Beech	16	Giresun	Standard
Oriental Beech	23	Kastamonu	Intensive
Oriental Beech	21	Amasya	Standard
Scotch Pine	4	Ankara	Intensive
Scotch Pine	14	Kayseri	Standard
Scotch Pine	18	Erzurum	Intensive
Greek Juniper	27	Mersin	Intensive
Greek Juniper	35	Isparta	Standard
Nordmann Fir	6	Bolu	Intensive
Nordmann Fir	49	Zonguldak	Standard
Eastern Spruce	17	Giresun	Intensive
Eastern Spruce	22	Trabzon	Standard
Lebanon Cedar	11	Antalya	Standard
Lebanon Cedar	28	Adana	Intensive

Figure 56. Installation of Level II observation sites; Calabrian Pine Observation site no. 12 (left) and Crimean Pine Observation site No.8 (right) (Photo: M. Bilgi)

Figure 57. Soil and Ecology Laboratory under Aegean Forestry Research Institute (Photo: Aegean Forestry Research Institute)

Certain drawbacks were encountered in the practice within the scope of the Level II Program. For some evaluation subjects, it is required to take samples at certain periods, for example weekly / bi-weekly or monthly samples, or to make observations (see Table 2). It is envisaged that the said studies should be carried out by the staff employed in intensive Level II observation sites, called as the field officers. Operation chiefs were considered to act as the field officers and therefore, operation chiefs were provided with trainings for this purpose. However, the works were disrupted due to the intensity of the tasks normally fulfilled by operation chiefs, and thus, the sampling could not be made in the desired quantity. In order to overcome this problem, permanently employed workers, who are at least / middle / high school graduates, are designated as the field officers; it is planned to give training to these field officers and to start sampling works at the end of their trainings.

Mixed stands of Cypress and Calabrian Pine, Serik, Antalya

8. CONCLUSIONS AND RECOMMENDATIONS

International Forestry Cooperation Program (ICP Forests) is a biomonitoring study continued in the widest area around the world. Continued for a period of over 25 years, these monitoring studies have contributed a lot in obtaining comprehensive results on problems such as air pollution and climate change and on the relationship between various stress factors and forest ecosystems. In addition, predictions for the future are also made with the help of the obtained results using various modeling.

The monitoring studies were started in Turkey in 2006, and it was only since 2008 that they could be extended to the entire forest areas. General Directorate of Forestry gives a great deal of importance to the ICP Forests Program, and founded a Forest Pests Monitoring Branch Directorate under the Forest Pest Combating Department, thus ensuring the monitoring studies to have an institutional state.

Important temporal and spatial findings were obtained on the health statuses of our forests in the studies carried out between the years 2008-2012 within the scope of the Forest Ecosystems Monitoring Program. Accordingly, the average leaf/needle loss ratios in Turkey forests are close to the European average, and as in Europe in general, health status of broadleaved species are worse than conifers.

The year 2008 was the worst year with respect to the health statuses of our forests, which was considered to be caused by the drought experienced during that year. During the following years, a steady improvement is observed in the health statuses of the monitored trees.

It is noteworthy to mention that Sessile Oak and Pubescent Oak species and Juniper species have higher leave/needle losses. Similarly, oak species in Europe have a worse health status than the other species.

When considered regionally, it is observed that health statuses of our forests in northern Turkey (Thrace included) and in the Central Anatolia region are slightly worse.

Although Level I studies are carried out successfully in our country, the works in Level II have not yet come to the desired state. It is thought that the need by part of the assessment subjects in Level II scope for laboratory works and periodic sampling in the site is effective on this situation. In addition, failure to fully operate the laboratory and to make up staff deficiency is another factor.

The recommendations for remedying the drawbacks and deficiencies in Level I and Level II studies within the scope of the Forest Ecosystems Monitoring Program and for improving the effectiveness of the program are listed below.

- Crown condition monitoring is a subjective assessment, for which the continuity of the evaluation team, their training and calibration are of great importance. For this reason, training of at least two times a year should be given in areas with different ecological characteristics in our country.
- Catalogs explaining how to determine the factors causing tree damage should be prepared and the teams should be trained. Although there are not serious issues concerning insect damages in this respect, trainings should focus on the symptoms of damage factors such as fungi, air pollution, ozone damage, drought, nutrient deficiency such damages should be given to training.
- The photograph catalog used in the crown condition assessment should be developed for the principal tree species (oak, juniper, etc.) and on a regional basis.
- The installation of the surveillance area or replacement of dead trees in tree species identification of problems arise during the election.
- Difficulties are experienced in diagnosing species when setting up observation sites or when selecting new trees instead of the dead ones. Therefore, assistance should be sought from the experts in Forestry Research Institutes or in Universities for the species posing difficulties of identification during the installation.
- All of the subjects within the scope of the Program have to be studied at certain periods and periodically. Therefore, attention should be given to timely provision of supplies, tools and equipments needed by the experts and assessment teams.
- All of the intensive Level II observation sites, planned to be 15 each units, have been fully set up. For this reason, studies should be initiated as soon as possible.
- Field officers should be determined in order to commence the works in intensive Level II observation sites. Appointment of the technical staff (forest guards, technicians, permanent workers of least high school graduates, etc.) rather than operation chiefs as the field officers will be appropriate and sufficient for the task. In order to avoid any interruption in the works, two technical staff should be assigned for each intense Level II observation site, thus creating a team total of 30 persons, which will ensure taking the samples in the field timely and in an accurate manner.
- All of the assessment subjects within the scope of the Program requires expertise. Therefore, continuity of the staff in their jobs (crown condition monitoring teams, national and regional experts for assessment subjects, field officers, laboratory staff) is important. Measures should be taken to ensure that the employed experts, when they retire from their duties, will transfer the documents under their disposal to the new experts who take over their jobs by means of the written minutes.
- Supervisions / inspections should be should be carried out effectively and timely in order to improve data quality.
- The website of the Program should be continuously updated to ensure the sharing of the obtained data with the interested parties.
- The communiqué prepared for the tasks of the staff and the tasks they will perform must be put into effect, it should be communicated to the officials assigned to work in the Program, and they should be accountable as may be necessary.
- About the work of officials held responsible and will see the notification, the program should be, should be able to account if necessary.
- Laboratory staff deficiency (Laborants, Laboratory Technicians, Chemical Engineers, etc.) have been made up, so the laboratory should enter the ring test field and the works should commence immediately.
- In order to enable the Program to proceed in a healthy manner, Regional Forestry Directorates and Research Institute in the provincial regions, and FPCD and FRTRD in the headquarters must fulfill their duties without any fail.
- OEI Program should be conducted integrated with such other applications as OEM Program and Climate Change Program.
- Attention should be paid to the ethical rules regarding data sharing, protecting the labor of those spending efforts.
- The results obtained from Level I and Level II studies should be published periodically, and they should be presented in international meetings, seminars and so on with respect to our country's prestige.

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APPENDIX

Appendix Table 1. Scientific Advisory Board

NAME – SURNAME	UNIVERSITY	DEPARTMENT
Prof. Dr. Doganay Tolunay	Istanbul University	Faculty of Forestry
Prof. Dr. Mahmut Eroglu	Karadeniz Technical University	Faculty of Forestry
Prof. Dr. Oktay Yildiz	Duzce University	Faculty of Forestry
Prof. Dr. Gürdal TUNCEL	Middle East Technical University	Environmental Eng.
Prof. Dr. Derya Esen	Duzce University	Faculty of Forestry
Assist. Prof. Dr. Sabri Ünal	Kastamonu University	Faculty of Forestry
Assist. Prof. Dr. Yasin Karatepe	Suleyman Demirel University	Faculty of Forestry
Assist. Prof. Dr. Nevzat Gürlevik	Suleyman Demirel University	Faculty of Forestry
Assist. Prof. Dr. Muhittin Inan	Istanbul University	Faculty of Forestry

Appendix Table 2. National Experts of Assessment Subjects

ASSESSMENT SUBJECT	NAME SURNAME	Place of Employment / INSTITUTION
Visual Assessment of Crown Condition and Damage Factors	Dr. Celal TASDEMIR	Eastern Mediterranean FRTC – TARSUS
	Fatih AYTAR	
Needle / Leaf Sampling and Analysis	Dr. Mehmet SAYMAN	Aegean FRTC - Izmir
	Ugur SAHIN	Forest Soil and Erosion RTC - ESKISEHIR
Tree Growth	Dr. Mustafa BATUR	Aegean FRTC - Izmir
	Ali Cem AYDIN	Western Mediterranean FRTC - ANTALYA
Phenological Measurements	Nilüfer SAHIN	FRTC Marmara - Istanbul
	Dr. Mehmet CALIKOGLU	Western Mediterranean FRTC - ANTALYA
Litter Sampling and Analysis	Giyasettin AKBIN	Aegean FRTC - Izmir
	Mehmet TÜRKKAN	Western Mediterranean FRTC - ANTALYA
Soil Sampling and Analysis	Muhammet KILCI	Aegean FRTC - Izmir
	Dr. Nejat CELIK	Forest Soil and Erosion RTC - ESKISEHIR
Soil Solution Sampling and Analysis	Dr. Sedat TÜFEKCI	Eastern Mediterranean FRTC - TARSUS
	Osman POLAT	Eastern Mediterranean FRTC - TARSUS
Sampling and Analysis of Deposition	Dr. Mustafa ZENGIN	Poplar and Fast Growing Forest Trees RTC - IZMIT
	Dr. Ahmet DUYAR	Western Black Sea FRTC - BOLU
Air Quality Monitoring	Hayati TEKIN	Marmara FRTC - ISTANBUL
	Ugur SAHIN	Western Black Sea FRTC - BOLU
Ozone Damage	Dr. Fazil SELEK	Poplar and Fast Growing Forest Trees RTC - IZMIT
	Dr. Saime BASARAN	Western Mediterranean FRTC - ANTALYA
Meteorological Measurements	Dr. Metin DEMIR	Eastern Anatolia FRTC - ERZURUM
	Ugur SAHIN	Western Black Sea FRTC - BOLU
Vegetation and Biodiversity	Dr. Nihal ÖZEL	Aegean FRTC - Izmir
	Mehmet TOKCAN	Western Black Sea FRTC - BOLU
Laboratory	Süha Ergin BILGIN	Aegean FRTC - Izmir
Data Base Management	Mehmet Emin AKKAS	Aegean FRTC - Izmir
	Murat BASER	Central Anatolia FRTC - ANKARA

FRTC: Forest Research and Training Center RTC: Research and Training Center

Appendix Table 3. Local Experts of Assessment Subjects

NAME SURNAME	PLACE OF EMPLOYMENT / INSTITUTION	IN CHARGE OF WHICH FORESTRY DIRECTORATES	SUBJECT FOR WHICH HE/SHE IS RESPONSIBLE
Dr. Meltem ÖZCANKAYA	Aegean FRTC - IZMIR	Izmir, Denizli, Mugla	VISUAL ASSESSMENT OF CROWN CONDITION AND DAMAGE FACTORS
Emre GÖKSU			
Süleyman MEMIS	Poplar and Rapid Growing Trees RTC - IZMIT	Bursa, Balikesir, Adapazari	
Dr. Fazil SELEK			
Erol CABAK			
Ilhami TURAN	Western Black Sea FRTC - BOLU	Bolu, Kastamonu, Zonguldak	
H. Ceyhun YURDABAK			
Dr. Mahir ERDEM			
Hüseyin KABA	Marmara FRTC - ISTANBUL	Istanbul	
Dr. Münevver ARSLAN	Forest Soil & Ecology RTC - ESKISEHIR	Kütahya, Eskisehir	
Dr. Seren CEYLAN	Central Anatolia FRTC - ANKARA	Konya, ANKARA, Kayseri, Amasya	
N. Bahadir SANLI			
Ayhan SERTTAS	Western Mediterranean FRTC - ANTALYA	Antalya, Isparta,	
Osman TIRYAKI	Southeastern Anatolia FRTC - ELAZIG	Elazig, Sanliurfa	
Cevdet AGYÜREK	Eastern Anatolia FRTC - ERZURUM	Erzurum	
Dr. Celal TASDEMIR	Eastern Mediterranean FRTC - TARSUS	Mersin, Adana, Kahramanmaras,	
Fatih AYTAR			
Necmettin EREN	Eastern Black Sea FRTC – TRABZON	Giresun, Trabzon, Artvin	
Dr. Mehmet SAYMAN	Aegean FRTC - IZMIR	Izmir, Denizli, Mugla	NEEDLE / LEAF SAMPLING AND ANALYSIS
Giyasettin AKBIN			
Ugur SAHIN	Forest Soil & Ecology RTC - ESKISEHIR	Eskisehir, Konya, Kütahya	
Mehmet TÜRKKAN	Western Mediterranean FRTC - ANTALYA	Antalya, Isparta	
Aysel OKUDAN			
Abdulkadir YILDIZBAKAN	Eastern Mediterranean FRTC - TARSUS	Mersin, Adana, Kahramanmaras	
Ömer ÖNCÜL	Eastern Anatolia FRTC - ERZURUM	Erzurum, Kayseri,	
Necmettin EREN	Eastern Black Sea FRTC – TRABZON	Trabzon, Giresun, Artvin	
Ragip AKDEMIR	Central Anatolia FRTC - ANKARA	ANKARA, Amasya	
Bahri KALKAN	Southeastern Anatolia FRTC - ELAZIG	Sanliurfa, Elazig	
Zehra ÖZPAY PALAZOGLU	Western Black Sea FRTC - BOLU	Kastamonu, Zonguldak, Bolu	
Ali Ayhan KUL	Marmara FRTC - ISTANBUL	Adapazari, Bursa, Balikesir, Istanbul	

FRTC: Forest Research and Training Center RTC: Research and Training Center

Appendix Table 3. Local Experts of Assessment Subjects

NAME SURNAME	PLACE OF EMPLOYMENT / INSTITUTION	IN CHARGE OF WHICH FORESTRY DIRECTORATES	SUBJECT FOR WHICH HE/SHE IS RESPONSIBLE
Dr. Mustafa BATUR	Aegean FRTC - IZMIR	Izmir, Mugla, Kütahya	TREE GROWTH
Ali Cem AYDIN	Western Mediterranean FRTC - ANTALYA	Antalya, Isparta, Denizli	
Abdulkadir YILDIZBAKAN	Eastern Mediterranean FRTC - TARSUS	Adana, Mersin, Kahramanmaras	
Askin BOZKURT	Poplar and Rapid Growing Trees RTC-IZMIT	Adapazari, Bursa	
Seyfettin KINIS	Western Black Sea FRTC - BOLU	Bolu, Zonguldak, Kastamonu	
Necmettin EREN	Eastern Black Sea FRTC – TRABZON	Trabzon, Giresun, Artvin	
Murat CETINER	Central Anatolia FRTC - ANKARA	Ankara, Amasya, Kayseri,	
Nihal ARGUN		Konya, Eskisehir	
Abbas SAHIN	Marmara FRTC - ISTANBUL	Istanbul, Balikesir,	
Caglar UGURLU	Eastern Anatolia FRTC - ERZURUM	Erzurum	
Bahri KALKAN	Southeastern Anatolia FRTC - ELAZIG	Elazig, Sanliurfa	
Nilüfer SAHIN	Marmara FRTC - ISTANBUL	Istanbul	PHENOLOGICAL OBSERVATIONS
Dr. Mehmet CALIKOGLU	Western Mediterranean FRTC - ANTALYA	Antalya	
Nihal ARGUN	Central Anatolia FRTC - ANKARA	Ankara, Konya, Eskisehir	
Pelin SENEL	Western Black Sea FRTC - BOLU	Bolu, Kastamonu	
Mustafa ARSLAN			
Zeynep Gülcin ALTUN	Aegean FRTC - IZMIR	Balikesir, Izmir	
Dr. Selda AKGÜL	Poplar and Rapid Growing Trees RTC-IZMIT	Adapazari	
Selvinaz YILMAZ	Eastern Black Sea FRTC – TRABZON	Giresun	
Lale BILGIN			
Murat KÖSE	Eastern Anatolia FRTC - ERZURUM	Erzurum	
Hakan KELES	Western Mediterranean FRTC - ANTALYA	Mersin, Kahramanmaras	
Giyasettin AKBIN	Aegean FRTC - IZMIR	Izmir, Balikesir	LITTERFALL SAMPLING AND ANALYSIS
Melihat TERZI	Western Mediterranean FRTC - ANTALYA	Antalya	
Adnan BILGILI	Eastern Anatolia FRTC - ERZURUM	Erzurum	
Necmettin EREN	Eastern Black Sea FRTC – TRABZON	Kastamonu, Giresun	
Ragip AKDEMIR	Central Anatolia FRTC - ANKARA	Ankara, Konya, Eskisehir	
Ülkü YURBUDAK	Western Black Sea FRTC - BOLU	Bolu, Adapazari	
Ali Ayhan KUL	Marmara FRTC - ISTANBUL	Istanbul	
Bahri KALKAN	Southeastern Anatolia FRTC - ELAZIG	Kahramanmaras, Mersin	

FRTC: Forest Research and Training Center RTC: Research and Training Center

NAME SURNAME	PLACE OF EMPLOYMENT / INSTITUTION	IN CHARGE OF WHICH FORESTRY DIRECTORATES	SUBJECT FOR WHICH HE/SHE IS RESPONSIBLE
Muhammet KILCI	Aegean FRTC - IZMIR	Izmir	SOIL SAMPLING AND ANALYSIS
Rasim DIRLIK	Regional Directorate of Forestry - IZMIR	Mugla	
Ayhan ALSAC			
Hüseyin KABAS	Regional Directorate of Forestry - DENIZLI	Denizli	
Erol CALISKAN			
Muhammet AKKAYA	Regional Directorate of Forestry - BALIKESIR	Balikesir	
Mehmet Ali CELEBI			
Zuhal YILMAZ	Regional Directorate of Forestry - ANKARA	Ankara, Konya	
Selahattin VELIOGLU	Regional Directorate of Forestry - TRABZON	Trabzon	
Selim SAHIN	Regional Directorate of Forestry - KMARAS	Kahramanmaras	
Irfan ARICI	Regional Directorate of Forestry - BURSA	Bursa	
Berrin ÖZER	Regional Directorate of Forestry - ISTANBUL	Istanbul	
Dr. Nejat CELIK	Forest Soil & Ecology RTC – ESKISEHIR	Eskisehir, Kütahya	
Mehmet TÜRKKAN	Western Mediterranean FRTC - ANTALYA	Antalya, Isparta	
Ali SEVIM	Eastern Black Sea FRTC – TRABZON	Giresun, Artvin	
Mehmet Akif OKUTUCU	Eastern Anatolia FRTC - ERZURUM	Erzurum, Kayseri	
Dr. Celalettin DURAN	Eastern Mediterranean FRTC - TARSUS	Mersin, Adana	
Ugur SAHIN	Western Black Sea FRTC - BOLU	Zonguldak, Kastamonu, Bolu	
Hüseyin YILMAZ			
Selin ÖZBAY	Poplar and Rapid Growing Trees RTC-IZMIT	Adapazari	
Bahri KALKAN	South Eastern Anatolia FRTC - ELAZIG	Elazig, Sanliurfa	
Havva KAPTAN	Department of Soil Conservation and Watershed Rehabilitation - ANKARA	Amasya	
Ercan ÖZYÜREK	Marmara FRTC - ISTANBUL	Istanbul	
Hayati TEKIN			

FRTC: Forest Research and Training Center RTC: Research and Training Center

NAME SURNAME	PLACE OF EMPLOYMENT / INSTITUTION	IN CHARGE OF WHICH FORESTRY DIRECTORATES	SUBJECT FOR WHICH HE/SHE IS RESPONSIBLE
Dr. Sedat TÜFEKCI	Eastern Mediterranean FRTC - TARSUS	Mersin, Kahramanmaras	SOIL SOLUTION SAMPLING AND ANALYSIS
Osman POLAT			
Selin ÖZBAY	Poplar and Rapid Growing Trees RTC - IZMIT	Adapazari	
Mehmet TÜRKKAN	Western Mediterranean FRTC - ANTALYA	Antalya	
Ali SEVIM	Eastern Black Sea FRTC – TRABZON	Giresun	
Cevdet AGYÜREK	Eastern Anatolia FRTC - ERZURUM	Erzurum	
Seda SENTÜRK	Aegean FRTC - IZMIR	Izmir, Balikesir	
Ugur SAHIN	Western Black Sea FRTC - BOLU	Kastamonu, Bolu	
Hüseyin YILMAZ			
Ercan ÖZYÜREK	Marmara FRTC - ISTANBUL	Istanbul	
Dr. Nejat CELIK	Forest Soil & Ecology RTC - ESKISEHIR	Ankara, Konya, Eskisehir	
Erol CABAK	Poplar and Rapid Growing Trees RTC - IZMIT	Adapazari	DEPOSITION SAMPLING AND ANALYSIS
Seda SENTÜRK	Aegean FRTC - IZMIR	Izmir	
Mehmet TÜRKKAN	Western Mediterranean FRTC - ANTALYA	Antalya	
Ali TOPAL	Eastern Mediterranean FRTC - TARSUS	Mersin, Kahramanmaras	
Necmettin EREN	Eastern Black Sea FRTC – TRABZON	Giresun	
Ragip AKDEMIR	Central Anatolia FRTC - ANKARA	Ankara, Konya, Eskisehir	
Yasar AYHAN	Eastern Anatolia FRTC - ERZURUM	Erzurum	
Fatih BASTAR	Western Black Sea FRTC - BOLU	Bolu, Kastamonu	
Cihangir DOGAN			
Hayati TEKIN	Marmara FRTC - ISTANBUL	Istanbul, Balikesir	
Avni ARSLAN			

FRTC: Forest Research and Training Center RTC: Research and Training Center

NAME SURNAME	PLACE OF EMPLOYMENT / INSTITUTION	IN CHARGE OF WHICH FORESTRY DIRECTORATES	SUBJECT FOR WHICH HE/SHE IS RESPONSIBLE
Dr. Fazil SELEK	Poplar and Rapid Growing Trees RTC - IZMIT	Istanbul, Balikesir	OZONE DAMAGE ASSESSMENT
Mahir ERDEM	Western Black Sea FRTC - BOLU	Zonguldak, Bolu, Kastamonu	
Özgür KIRACIOGLU	Aegean FRTC - IZMIR	Mugla, Kütahya, Izmir	
Dr. Saime BASARAN	Western Mediterranean FRTC - ANTALYA	Antalya, Isparta, Denizli	
Selda AKGÜL	Poplar and Rapid Growing Trees RTC - IZMIT	Adapazari, Bursa	
Lale BILGIN	Eastern Black Sea FRTC – TRABZON	Trabzon, Giresun	
Mehtap ÖZTEKIN	Central Anatolia FRTC - ANKARA	Eskisehir, Amasya, Konya, Ankara	
Nihal ARGUN			
Bahri KALKAN	Southeastern Anatolia FRTC - ELAZIG	Mersin, Kahramanmaras, Adana, Sanliurfa	
Beyza ERSOY	Eastern Anatolia FRTC - ERZURUM	Erzurum, Kayseri	
Dr. Metin DEMIR	Eastern Anatolia FRTC - ERZURUM	All regions where Level 2 has been set up	METEOROLOGICAL MEASUREMENTS
Ugur SAHIN	Western Black Sea FRTC - BOLU		
Yusuf Salih EROGLU	MGM		
Mustafa MOROVA	MGM		
Avni ARSLAN	Marmara FRTC - ISTANBUL	Istanbul, Balikesir	AIR QUALITY MONITORING
Hayati TEKIN			
Ugur SAHIN	Western Black Sea FRTC - BOLU	Bolu, Kastamonu	
Selda AKGÜL	Poplar and Rapid Growing Trees RTC - IZMIT	Adapazari	
Osman POLAT	Eastern Mediterranean FRTC - TARSUS	Mersin, K.Maras	
Lale BILGIN	Eastern Black Sea FRTC – TRABZON	Giresun	
Mehtap ÖZTEKIN	Central Anatolia FRTC - ANKARA	Eskisehir, Konya, Ankara	
Nihal ARGUN			
Beyza ERSOY	Eastern Anatolia FRTC - ERZURUM	Erzurum	
Özgür KIRACIOGLU	Aegean FRTC - IZMIR	Izmir, Antalya	
Dr. Nihal ÖZEL	Aegean FRTC - IZMIR	All regions where Level 2 has been set up	VEGETATION AND BIODIVERSITY
Mehmet TOKCAN	Western Black Sea FRTC - BOLU		
Assistant Prof. Dr. Ali KAVGACI	Western Mediterranean FRTC - ANTALYA		
Dr. H. Handan ÖNER	Aegean FRTC - IZMIR		
Mehtap ÖZTEKIN	Central Anatolia FRTC - ANKARA		

FRTC: Forest Research and Training Center RTC: Research and Training Center

Appendix Table 3. Organization Chart

FOREST ECOSYSTEM MONITORING PROGRAM

EXECUTIVE BOARD

President: GDF - Assistant General Manager **Co-Chair: GDF – FPCD Head** **MEMBERS: GDF – FRTR Department Head** **MEMBERS: GDF – FMP Department Head** **MEMBERS: GDF - IS Department Head**	**OTHER MEMBERS** **GDF - FPCD – FEMBD – NFBD Department Head** **GDF – FMPDH - NFBD - Branch Director** **GDF – FRTRD - APPBD - Branch Director**

SCIENTIFIC ADVISORY BOARD

President : Academic Instructor **Vice President : Academic Instructor**	**MEMBERS** **IU - FACULTY OF FORESTRY** **KTU - FACULTY OF FORESTRY** **DU - FACULTY OF FORESTRY** **KU - FACULTY OF FORESTRY** **METU - ENVIRONMENTAL ENGINEERING** **SDU - FACULTY OF FORESTRY** **NATIONALLY RESPONSIBLE OFFICIALS**

NATIONAL FOCUS CENTER
(FOREST ECOSYSTEMS MONITORING BRANCH DIRECTORATE)

President: GDF - FEMBD - Branch Director
Vice President: GDF - FRTRDH - APPBD - Branch Director

LEVEL I COORDINATION UNIT
- Installation and Assessment - Data Entry
- Level II Permanent Observation Site Management
- Supervision / Control
- National and International Reporting

Level I Program
Database Management Officer: EOAEM- Expert
Datab. Mng. Officer Assistant: IAOAEM - Expert
Database Management - Inspection and Reporting

Secretariat - Archive and Documentation

LEVEL II COORDINATION UNIT
- CENTRAL COORDINATION UNIT
- PROVINCIAL COORDINATION UNIT
- Installation and Assessment - Data Entry
- Level II Permanent Observation Site Management
- Supervision / Control
- National and International Reporting

LABORATORY
Laboratory Officer: EOAEM - Expert

Level I Program
Database Management Officer: EOAEM- Expert
Datab. Mng. Officer Assistant: IAOAEM - Expert
Database Management - Inspection and Reporting

Abbreviations:

GDF: General Directorate of Forestry	FMP: Forest Management and Planning
FPCD: Forest Pets Control Department	FMPDH: Forest Management and Planning Department Head
FEMBD: Forest Ecosystems Monitoring Branch Directorate	IS: Information Systems Department Head
FRTRD: Foreign Relations, Training and Research Department	NFBD: National Forests Branch Directorate
RPPBD: Research Plan Program Branch Directorate	APPBD: Afforestation Plan Program Branch Directorate

NOTES