Monitoring the Italian forests

The Italian National forest Service, in addition to other institutional duties, carries out forest monitoring through two working programs: the National Forest and Carbon Sink Inventory (INFC) and the National Network for Forest Ecosystems Control (CONECOFOR)

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National Forest and Carbon Sink Inventory (INFC)

The second Italian national forest inventory (the first one was published in 1985) is named "National Inventory of Forests and forest Carbon pools" whose acronym in Italian is INFC. INFC is performed by CFS with the scientific coordination of CRA-MPF (www.sito.entecra.it) and in co-operation with the Italian Ministry of the Environment (www.minambiente.it).

The national forest inventory developed a three-phase sampling research. To assess the land cover/land use class, during the **first phase** approximately 300,000 sample points, randomly located on a 1-km x 1-km grid covering the whole Italian territory, were photo-interpreted on digital orthophotos by 50 NFS technicians. The FAO-Forest Resources Assessment (FRA) definition of Forest and Other Wooded Land (OWL) was adopted. The "Total Wooded Area" is given by Forest and OWL together.

The **second phase** allowed to finalize the classification of sample points, estimating separately Forest and OWL areas assigned to the same land cover/use class by the photo-interpreters, and to separate the sample points into eight inventory categories, 23 vegetation types and 91 sub-types using a national classification scheme. The second phase has been implemented through field surveys on a sub sample of 30,000 points randomly selected from the Forest and Other Wooded Land stratum. By this phase, information on 40 qualitative attributes was collected, such as the management status, stand origin and structure, health condition, slope instability and erosion, etc. Administrative information, such as ownership, protection status, management plans, etc., has been collected through interviews or public database queries, while digital orthophotos were used in the field to assess crown cover, texture (horizontal spatial distribution of trees), and forest edges.

In the **third phase** field surveys were carried out to obtain quantitative measurements of trees and assessments of stand attributes. Among the attributes related to dendrometric measurements, lying and standing dead wood was measured. Silvicultural aspects were assessed as well as stand health condition and non timber goods production. Measurements were taken on approximately 7,000 points randomly selected from the second phase sample and stratified by ad-

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ministrative region and forest type (see www.infc.it).
The field monitoring activities started in 2003 and were concluded at the end of 2008. During this period the CFS staff took lots of data from Italian forests.
During 2010 the CFS, with the scientific coordination of CRA-MPF, realized an inventory of forest soil carbon content to complete the research on the fifth forest carbon sink expected from the Kyoto Protocol: ground plant biomass, underground plant biomass, dead wood, litterfall and soil.
All these parameters have been carefully analyzed and estimated at regional and national level. The surveys consider forests as a whole as well as their main categories (tree species, structure, forest management).
First results show that in Italy:

- there are 12 billion trees distributed on 10.467.533 hectares of forest areas (Fig. 1);
- beech is the most common species: there are more than 1 billion beech trees covering almost all the Apennines;
- forests contain more than 1.260.000.000 m^3 of wood (144 m^3 ha^{-1}), i.e., more than 870.000.000 tons of wood (100 t ha^{-1}) meaning about 435.000.000 tons of stocked carbon;
- The total annual gross increment is 35.862 Mio m^3 and the Annual gross increment is 4.1 m^3 ha^{-1};
- The total deadwood is 70.000.000 m3 (8 m^3 ha^{-1}).

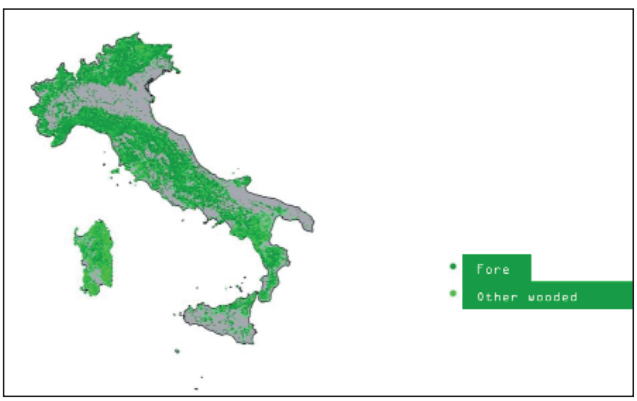

FIGURE 1 INFC results
Source: Consiglio per la Ricerca e la Sperimentazione in Agricoltura (CRA)

These data are very important for the Italian economy in the framework of the Kyoto Protocol. The storage of Carbon dioxide in our forests can decrease the amount of Italian greenhouse gas emissions: this particular effect could be estimated in about 1.000.000.000 euro within the mechanism of the Kyoto Protocol Italian commitments.

The CONECOFOR Programme: National net for Forest Ecosystems Control

Forest condition monitoring at national scale has been promoted in Italy since 1987 under the coordination of the National Forest Service and the cooperation of Research Centres of national relevance (CRA, CNR, Italian Universities). The programme named CONECOFOR (Forest Ecosystems Monitoring) started in 1995 and involved investigations on 265 Level 1 plots (large scale monitoring) and 31 Level 2 plots (intensive monitoring), in the framework of the UN/ECE Convention on Long-range Transboundary Air Pollution, in cooperation with ICP Forests and ICP IM.
During the last 15 years the CONECOFOR programme was co-financed by the EC through some EU Regulations (e.g., Forest Focus) and by the LIFE + FutMon project for the years 2009-2010. The activities carried out during the years 2008 and 2011 were financed directly by CFS in the absence of EU co-financing to avoid a gap inside the data series.

Working Programme

The CONECOFOR net is composed by 31 plots which are widespread in Italy to represent all the main forest types (beech, pine tree, oak species, plain forests, etc.).
The large-scale monitoring consists in annual forest assessment on 265 Level I plots (Fig. 2), where the health of trees is studied.
In 2009-2010 the research institute *Consiglio per la Ricerca e la Sperimentazione in Agricoltura – Unità di Ri-*

FIGURE 2 Level I: Estensive Network
Source: CONECOFOR Service

FIGURE 3 NFI plots selected for Level I CONECOFOR plots
Source: CRA

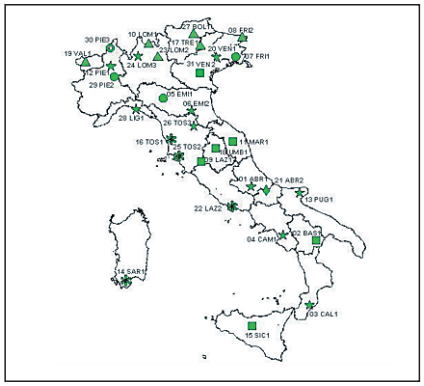

FIGURE 4 Level II: Intensive work
Source: CONECOFOR Service

cerca per il Monitoraggio e la Pianificazione Forestale (CRA-MPF) started the implementation of a large-scale representative monitoring grid (Fig. 3).

It revised the existing monitoring system and its integration with the network of sampling of the later National Forest Inventory (NFI).

A new protocol introducing the major principles and criteria adopted for the current monitoring system NFI was developed. In 2009, the protocol applied to Level I plots was made more similar to protocol NFI, maintaining the previous criteria for the selection of the subjects to detect; in 2010, the protocol applied in the two systems was rather the same for all aspects.

During the last 3 years 600 plots were monitored according to this new scheme.

In particular:

- **meteorological measurements and water budgets** analysis are being carried out by Consiglio per la Ricerca e la Sperimentazione in Agricoltura – Centro di ricerca per lo studio delle Relazioni tra Pianta e Suolo (CRA–RPS) since 1996. This activity allows to define the climatic characteristics of the areas, assess the climatic indices and associated risk factors, identify the extraordinary events and climate trends and evaluate the hydrological balance.
- **deposition and ozone measurements in forest** are carried out by Consiglio Nazionale delle Ricerche - Istituto per lo Studio degli Ecosistemi (CNR-ISE) since 1997, by sampling the atmospheric deposition in the open air under the canopy and along the trunks and waterways, and measuring ozone by passive samplers (Fig. 5);

  CNR also performs the **evaluation and improvement of the analytical quality in laboratories** analyzing deposition and soil solutions since 2002. It organizes a series of intercalibration exercises and arranges visits on request to evaluate the analytical quality in laboratories involved in the ICP Forests, to verify problems on the spot and suggesting solutions.
- the Consiglio Nazionale delle Ricerche – Istituto di Biologia Agroambientale e Forestale (CNR-IBAF) is involved in the **sampling and analysis of needles and leaves** (since 1995), **litterfall and nutrient**

FIGURE 5 Sampling instruments: colleptor for precipitation quantity- stem flow - ozone
Source: CNR

cycling and critical loads (since 2009). This activity allows to: assess the nutritional status of the monitored forests; compare the different concentrations of nutrient for different years of sampling and for different species; test the degree of concordance between the values found in the Italian sites and the critical loads established at European level (for any nutritional imbalances) and investigate the reasons for the differences found; analyze any differences that occurred during the monitoring period; investigate the differences between the concentrations found in the leaves and litterfall.

- the **tree growth analysis** is carried out by the Consiglio per la Ricerca e la Sperimentazione in Agricoltura, Centro di ricerca per la Selvicoltura di Arezzo (CRA–SEL) since 1996. It consists in periodic sampling and measurements of the main tree growth parameters (diameter; basal area, height and/or volume).
- the University of Florence (Biotecnologie Agrarie Department) and Linnaeambiente R.A. srl (Florence) carry out the **annual visual assessment of crown condition and damaging agents** including removals and mortality, since 1996. This activity is carried out also on Level I CONECOFOR plots (Fig. 6 e 7).

Since 2001 these institutes also study the **annual visible ozone injury on vegetation assessment** in Lev. II CONECOFOR plots, where ozone passive samplers are installed. This analysis aims at evaluating the risk of ozone damage on forests (Fig. 8-9).

- University of Florence first, and TerraData environmetrics (academic spin-off University of Siena) then, on behalf of CONECOFOR, carries out the **integrated management and processing of data collected** since 1995. This activity consists in collecting data from the monitoring in Level II CONECOFOR plots and developing indicators for the different response of forest in these plots.
- TerraData environmetrics, on behalf of CONECOFOR, made also the **trans-national coordination of data quality assurance and data quality control** in all phases of data management in 2009-2010. This activity consists in coordinating the harmonization of methods from the definition of procedures for collecting up the sampling to data evaluation and processing. From the integration of

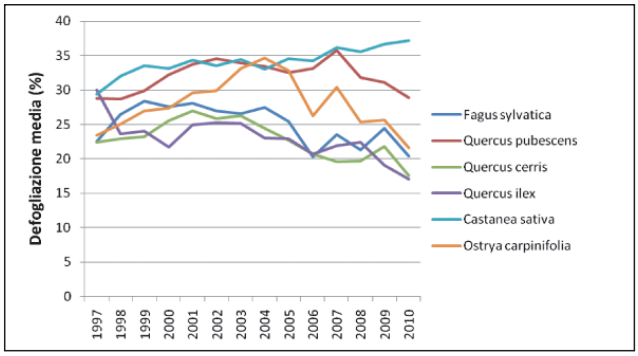

FIGURE 6 Average values of defoliation for deciduous
Source: Linneambiente R.A. srl

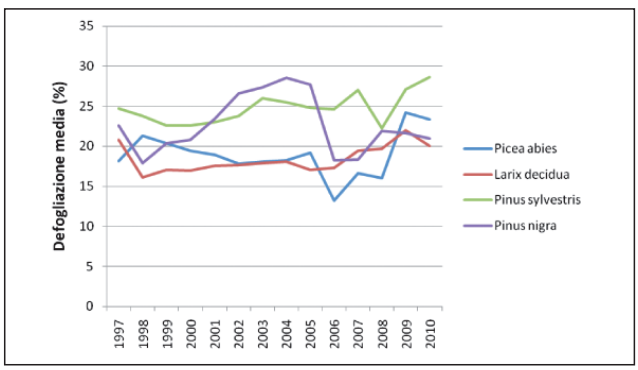

FIGURE 7 Average values of defoliation for conifers
Source: Linneambiente R.A. srl

FIGURE 8
Ozone symptoms on Acer pseudoplatanus
Source: University of Florence

FIGURE 9
Ozone symptoms on Populus spp
Source: University of Florence

different methodologies, a single manual of standard operating procedures was established.

Main Recent Results

The survey of level I in 2010 took into consideration the condition of the crown by 8338 selected trees in 253 plots belonging to the EU network 16x16 km. The number of sample areas has decreased by 4 units compared to the survey of 2009 following the failure to meet the requirements for the feasibility of the area (threshold diameters, dominance, etc.). The number of plants has increased considerably as a result of integrating the second adjustment inventory model.
By analyzing the sample for groups of species, conifers and broadleaves, it appears that conifers suffer **defoliation** less than deciduous trees: 31.8% of conifers and 21.3% of broadleaves do not present any defoliation.
The 93.1% of conifers and 95.8% of broadleaves have no problem of **discoloration.**
Starting from 2005, a new methodology for a deeper assessment of damage factors (biotic and abiotic) was introduced. Most of the observed symptoms were attributed to insects (25.5%), subdivided into defoliators (19,1%), wood borers (1.9%), aphids (0.9%), needle miners (0.8%), following symptoms attributed to fungi (5.9%), the most significant being attributed to "dieback and canker fungi" (3.4%), then those assigned to abiotic agents, the most significant one being the "hail" (1.6%).

In 15 years of monitoring forest conditions in Level 2 plots, the combined and integrated data evaluation shows the particular risk of high acid and nitrogen deposition for sensitive soils and biodiversity status. Ozone concentrations exceed the critical level at all monitoring sites, especially in summer, and reduce the vitality of sensitive forest species. Ozone affects crown transparency (defoliation) and is related to carbon sequestration through its effects on tree growth. Such data confirms that ozone represents a potential risk factor for Italian forests.

LIFE+ projects

In recent years the CONECOFOR Service monitoring activities have been co-financed by the EU through LIFE+ projects. In fact it participates in the EnvEurope Project, while the FutMon Project has just concluded (2009-2010) and another LIFE+ Project was presented in the 2011 "call".

"Further Development and Implementation of an EU-level Forest Monitoring System (FutMon)"
Reg. (CE) n.614/2007 LIFE+
Progetto n. LIFE07 ENV/D/000218

FutMon (www.FutMon.org) was a 2-year LIFE+ project (2009-2010) establishing a long term monitoring system on the health of European Forests.
The aim of FutMon is the establishment of a pan-European forest monitoring system serving as a basis for the provision of policy relevant information on forests in the European Union as required under international obligations and key action 8 of the Forest Action Plan (COM 2006 final).
Moreover, the Project aims at improving the monitoring system through the integration and harmonization of National Inventories and Monitoring Networks (Lev. 1 and 2) of the involved European Countries.
FutMon, coordinated by the German research institute vTI (www.vti.bund.de), was carried out by 38 beneficiaries from nearly all EU-Member States (Italians Associated beneficiaries: C.F.S., C.N.R. and C.R.A.).

ENVEurope "Environmental quality and pressures assessment across Europe"

ENVEurope (www.enveurope.eu) is a 4-year LIFE+ Project (2010–2013) proposing a design for environ-

mental high quality monitoring and long-term research sites: it represents the exemplary establishment of common parameter sets to be collected across the largest site-based network of Long-Term Ecosystem Research in Europe (www.lter-europe.net), which was recently established (2006) under the auspices of the FP6 Network of Excellence ALTER-Net, building on existing infrastructures and thus a lot of valuable data series. http:77www.alter-net.info/

The Project, internationally coordinated by CNR-ISMAR, is focused on three types of ecosystems (terrestrial, freshwater and marine), and it aims at defining research and monitoring activities relevant to different levels/scales of investigation. The project has been designed and planned in the conceptual and operative context of SEIS (http://ec.europa.eu/environment/seis) and will also contribute to the development of the GMES (http://ec.europa.eu/gmes) initiative.

CONECOFOR Service, in co-operation with the National Center for Study and Forest Biodiversity "Bosco della Fontana" of CFS, is an Associated Beneficiary of this LIFE+ Project together with other 15 Research Institutes from 12 different European Countries. In particular, it is involved in monitoring terrestrial sites and coordinates the action for a proposal of a new ecological network.

More info

- www.corpoforestale.it
- www.icp.forest (ICP manual: http://icp-forests.net/page/icp-forests-manual)
- CRA www.sito.entecra.it
- CNR www.cnr.it
- FutMon Project http://www.sian.it/inventarioforestale/jsp/futmon.jsp
- INFC www.infc.it

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