

The CONECOFOR programme from 1995 to 2005

Bruno Petriccione¹

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Abstract – Climate change, ozone effects on forests as well as the loss of biodiversity are nowadays the top priorities of environmental monitoring programmes in Europe. The first set of twenty Level II PMPs (Permanent Monitoring Plots) of the CONECOFOR programme was installed in 1995. At the moment, the intensive monitoring network includes 31 PMPs. All the plots were framed into the UN/ECE ICP-Forests; since 1998, 10 plots were also included into the UN/ECE ICP-IM as bio-monitoring sites. With the entering into force of EC Regulation Forest Focus, these new priorities found an EU legal basis for co-funding the related pilot projects, developed at trans-national level in the field of forest biodiversity monitoring: *ForestBIOTA* and *BioSoil*. In the frame of the EEA programme SEBI2010, a specific qualitative forest indicator has been developed by the Italian Forest Service. The Forest Status Indicator is based on sub-indicators identified and implemented at pan-European and National level, such as tree condition, forest structure, deadwood, plant species composition and naturalness, mostly available at European level and collected according to harmonized methods. In 2004, the Italian Forest Service (CONECOFOR Board) joined the Network of Excellence *ALTER-Net*. The participation to *ALTER-Net* gave the opportunity to Italy to become official member of the International Long Term Ecological Research Network (ILTER) in 2006: four LTER-Italy sites include forest environments and 10 research stations (plots) belong to CONECOFOR Level II network. At international level, CONECOFOR is the leader in *FutDiv* proposal (Future Forest Biodiversity Monitoring in Europe) and an associated beneficiary in the *FutMon* proposal (Further Development and Implementation of an EU-level Forest Monitoring System), already submitted under the EC Regulation LIFE+.

Key words: *forest management, CONECOFOR, biodiversity.*

Riassunto – Il programma CONECOFOR dal 1995 al 2005. Gli effetti dei cambiamenti climatici e dell'ozono troposferico, così come la perdita di biodiversità, sono divenute oggi le priorità assolute di tutti i programmi paneuropei di monitoraggio ambientale. Le prime venti aree di monitoraggio permanente di Livello II del Programma CONECOFOR sono state installate nel 1995. Oggi, la rete di monitoraggio intensivo comprende 31 aree. Tutte fanno parte della Rete UN/ECE-ICP Forests; a partire dal 1998, 10 aree sono state anche incluse nella Rete UN/ECE ICP-IM come siti di monitoraggio biologico. Con l'entrata in vigore del Regolamento (EC) Forest Focus, queste nuove priorità hanno finalmente trovato una base giuridica per il co-finanziamento dei relativi progetti pilota, sviluppati a livello trans-nazionale nel campo del monitoraggio della biodiversità forestale: *ForestBIOTA* e *BioSoil*. Nel quadro del programma dell'EEA SEBI2010, il Corpo Forestale dello Stato ha sviluppato uno specifico indicatore qualitativo. Il *Forest Status Indicator* è basato su sub-indicatori identificati ed applicati a livello pan-europeo e nazionale, come condizione delle chiome, struttura forestale, legno morto, composizione di specie vegetali e naturalità, generalmente disponibili a livello europeo e raccolti secondo metodi armonizzati. Nel 2004, il Corpo Forestale dello Stato (Ufficio CONECOFOR) ha contribuito alla costituzione del Network di Eccellenza *ALTER-Net*. La partecipazione ad *ALTER-Net* ha dato all'Italia la possibilità di diventare ufficialmente membro della Rete di Ricerche Ecologiche a Lungo Termine ILTER nel 2006: quattro siti LTER-Italia comprendono ambienti forestali e 10 stazioni di ricerca fanno parte della Rete CONECOFOR di Livello II. A livello internazionale, CONECOFOR è leader del progetto *FutDiv* (Futuro Monitoraggio della Biodiversità Forestale in Europa) e partecipa al progetto *FutMon* (Ulteriore Sviluppo ed Applicazione di un Sistema di Monitoraggio delle Foreste a livello di Unione Europea), già presentati nell'ambito del Regolamento (EC) LIFE+.

Parole chiave: *monitoraggio delle foreste, CONECOFOR, biodiversità.*

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Introduction

To better understand the current situation, it is important to recall the origin of the programme CONECOFOR (acronym from the Italian CONtrollo ECOsistemi FOrestali, Forest Ecosystem Monitoring). CONECOFOR is the intensive monitoring programme of forest ecosystems in Italy: it was launched in 1995 and is managed from the very beginning by the Corpo

Forestale dello Stato, CONECOFOR Board, acting also as Italian National Focal Center (NFC) within the EU and UN/ECE programmes. In fact, CONECOFOR is the Italian technical and scientific tool for the implementation of several EU and UN/ECE programmes: the EU policy for monitoring and protecting the European forest from the atmospheric pollution (EU Regulation n°. 1091/94 and n°. 2152/2003 Forest Focus, co-funding the Programme); the UN/ECE Convention on Long Range

¹ Corpo Forestale dello Stato - CONECOFOR Service, via Carducci 5, 00187 Roma (Italy) conecofor@corpoforestale.it

Trans-boundary Air Pollution (CLRTAP), ratified by Italy in 1982; and the Resolutions of the Ministerial Conferences on the protection of forests in Europe.

It is worth noting that the EU and the UN/ECE Programmes were launched as a response to the major concern generated by the air pollution effects on biota, including forest ecosystems. Today the overall picture has changed a lot: not only the concern about the effects of air pollutants on forests has been decreasing, but also the legal framework has changed and the knowledge gained originated a revision of the environmental priorities. Climate change, ozone effects on forests as well as the loss of biodiversity are nowadays the top priorities of environmental monitoring programmes in Europe and elsewhere. While CONECOFOR was considering these themes for from the very beginning, over the past ten years several changes have occurred in the structure of the programme.

Development and changes in the network structure

Permanent Monitoring Plots

The first twenty Level II Permanent Monitoring Plots of the CONECOFOR programme were installed in 1995 (Figure 1). A few of these plots were already existing, as they were installed on a regional basis during the 1980s and early 1990s, when only a national early-warning systematic network (the so-called Level I network) was operative. Between 1999 and 2003, the network's geographical and ecological coverage was improved, with the inclusion of eleven new plots in Northern and central Italy, including also forest types like holm oak and flood-plain forests, and high elevation spruce and larch forests. At the moment, the intensive monitoring network includes 31 Level II plots (Figure 1; Table 1). All the Level II plots were framed into the UN/ECE ICP-Forests (International Co-operative Programme for monitoring the effects of atmospheric pollution on Forests); starting from 1998, 10 plots were also included as bio-monitoring sites into the UN/ECE ICP-IM (International Co-operative Programme for Integrated Monitoring of the effects of atmospheric pollution on ecosystems).

Investigations

Figure 2 reports the progress of the "traditional" investigations on the original 20 plots installed in 1995.

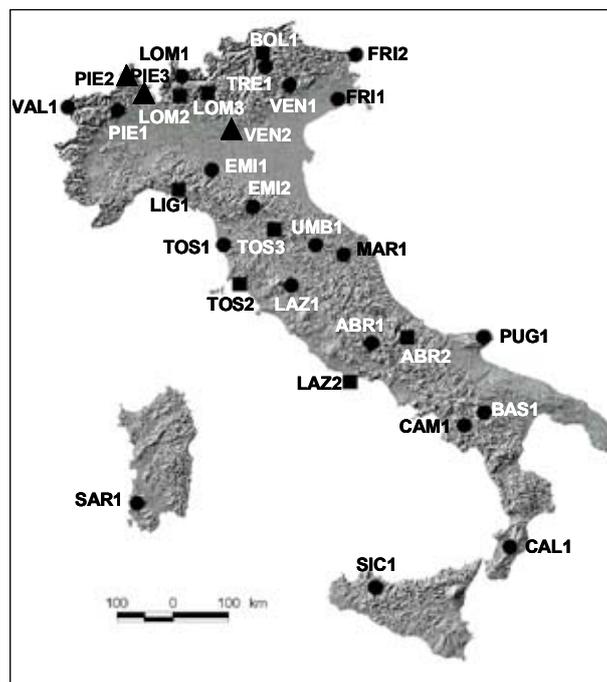


Figure 1 - The location of the Permanent Monitoring Plots of the CONECOFOR programme. Circles: PMPs operational within the programme since 1995; squares: PMPs that have joined the programme in 1999-2000; triangles: PMPs incorporated in 2002-2003.

Localizzazione delle aree permanenti di monitoraggio del programma CONECOFOR. I cerchi indicano le aree permanenti operative fino dal 1995; i quadrati indicano le aree incorporate nel 1999-2000; i triangoli quelle inserite nel 2002-2003.

A clear increase in the number of investigations and plot coverage is obvious over the period 1995-2005. It is worth noting that most analyses presented in this report were based on the investigations and on the number of plots reported in Figure 2. On the other hand, Table 2 reports the investigations carried out at all the plots. In the future, new surveys belonging to the top priority areas (biodiversity and climate change) will be implemented at the selected core sites (see below), on larger areas like catchments, taking into account new scales of investigation and the relationship among different *ecocoenotopes* (landscape approach).

Expertise and CONECOFOR staff

Alongside with the changes in the investigations, the experts in charge for the "traditional" surveys have been complemented in the time by new experts in the field of biodiversity, climate change and landscape ecology.

Table 1 – Permanent Monitoring Plots (PMPs) of the CONECOFOR programme over the period 1995-2005. Asterisks indicate the PMPs incorporated in the ICP-IM. In brackets: cases of PMPs installed outside the CONECOFOR programme and subsequently incorporated in the programme. The report will concentrate mainly on the first 20 PMPs, e.g. those operational since 1995.

Are e permanenti del programma CONECOFOR nel periodo 1995-2005. Gli asterischi indicano le aree permanenti incorporate in ICP-IM. Tra parentesi: i casi di aree installate indipendentemente da CONECOFOR e successivamente incorporate nel programma. Il rapporto si concentrerà principalmente sulle prime 20 aree, cioè quella attive dal 1995.

PMP no.	Code	Lat	Long	Elevation (m a.s.l.)	Main tree species	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
1	*ABR1	415051	133523	1500	<i>Fagus sylvatica</i>	+	+	+	+	+	+	+	+	+	+	+
2	BAS1	403638	155225	1125	<i>Quercus cerris</i>	+	+	+	+	+	+	+	+	+	+	+
3	*CAL1	382538	161047	1100	<i>Fagus sylvatica</i>	+	+	+	+	+	+	+	+	+	+	+
4	CAM1	402558	152610	1175	<i>Fagus sylvatica</i>	+	+	+	+	+	+	+	+	+	+	+
5	*EM1	444306	101213	200	<i>Quercus petraea</i>	+	+	+	+	+	+	+	+	+	+	+
6	*EM2	440631	110700	975	<i>Fagus sylvatica</i>	+	+	+	+	+	+	+	+	+	+	+
7	FRI1	454734	130715	6	<i>Q. robur/Carpinus betulus</i>	+	+	+	+	+	+	+	+	+	+	+
8	FRI2	462928	133536	820	<i>Picea abies</i>	+	+	+	+	+	+	+	+	+	+	+
9	*LAZ1	424950	130010	690	<i>Quercus cerris</i>	+	+	+	+	+	+	+	+	+	+	+
10	*LOM1	461416	93316	1190	<i>Picea abies</i>	+	+	+	+	+	+	+	+	+	+	+
11	*MAR1	431738	130424	775	<i>Quercus cerris</i>	+	+	+	+	+	+	+	+	+	+	+
12	PIE1	454055	80402	1150	<i>Fagus sylvatica</i>	+	+	+	+	+	+	+	+	+	+	+
13	PUG1	414910	155900	800	<i>Fagus sylvatica</i>	+	+	+	+	+	+	+	+	+	+	+
14	SAR1	392056	83408	700	<i>Quercus ilex</i>	+	+	+	+	+	+	+	+	+	+	+
15	SIC1	375432	132415	940	<i>Quercus cerris</i>	+	+	+	+	+	+	+	+	+	+	+
16	*TOS1	433034	102619	150	<i>Quercus ilex</i>	+	+	+	+	+	+	+	+	+	+	+
17	*TRE1	462137	112942	1775	<i>Picea abies</i>	+	+	+	+	+	+	+	+	+	+	+
18	UMB1	432757	122757	725	<i>Quercus cerris</i>	+	+	+	+	+	+	+	+	+	+	+
19	*VAL1	454326	65555	1740	<i>Picea abies</i>	+	+	+	+	+	+	+	+	+	+	+
20	VEN1	460326	120156	1100	<i>Fagus sylvatica</i>	+	+	+	+	+	+	+	+	+	+	+
21	ABR2	415409	142100	980	<i>Q. cerris/C. betulus/Abies alba</i>								+	+	+	+
22	LAZ2	415051	133523	190	<i>Quercus ilex</i>								+	+	+	+
23	LOM2	455726	100753	1150	<i>Picea abies</i>		(+)	(+)	(+)	+	+	+	+	+	+	+
24	LOM3	455441	93017	1250	<i>Fagus sylvatica</i>					+	+	+	+	+	+	+
25	TOS2	425212	104634	30	<i>Quercus ilex</i>	(+)	(+)	(+)	(+)	+	+	+	+	+	+	+
26	TOS3	434418	113422	1170	<i>Fagus sylvatica</i>	(+)	(+)	(+)	(+)	+	+	+	+	+	+	+
27	*BOL1	463516	112604	1740	<i>Picea abies</i>	(+)	(+)	(+)	(+)	(+)	+	+	+	+	+	+
28	LIG1	442410	92730	1290	<i>Fagus sylvatica</i>							(+)	+	+	+	+
29	PIE2	453129	84234	135	<i>Quercus robur, Carpinus betulus</i>											+
30	PIE3	461958	81650	1860	<i>Larix decidua</i>											+
31	VEN2	451203	104408	60	<i>Quercus robur, Carpinus betulus</i>											+

In the early 2000s, the central coordination team CONECOFOR has been enforced with new staff members, from the forestry and ecology sectors. Nowadays, the team is able to directly manage project preparation and implementation in many field of long-term forest and ecosystem monitoring.

Staff members and experts have meetings two- to three times per year within the frame of the Task Force for the Integrated and Combined Evaluation of the CONECOFOR data.

Products

The huge amount of data collected in the first 10 years of CONECOFOR activity has been the basis for publishing several scientific reports, elaborated through a joint collaboration among all researchers participating to the CONECOFOR activities, under the Task Force for the Integrated and Combined Evaluation CONECOFOR.

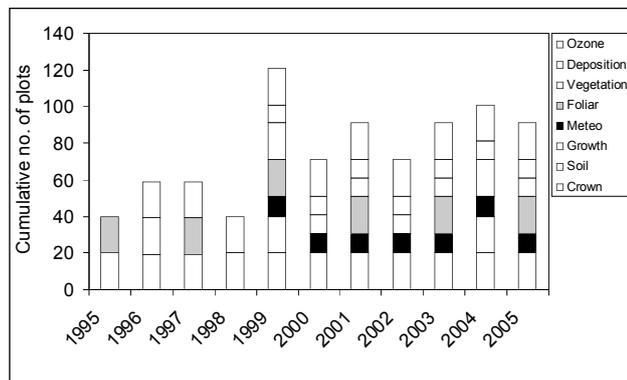


Figure 2 - The cumulative number of plots (sum of the plots operational for each investigation) over the period 1995-2005. *Numero cumulato di aree (somma delle aree attive per ogni indagine) nel periodo 1995-2005.*

A synthetic report describes the scientific activities in place in the CONECOFOR Level II network (MOSELLO *et al.* 2002), whereas three reports are based on the Integrated & Combined evaluation of data (FERRETTI

Table 2 – Investigation categories carried out at the PMPs of the CONECOFOR programme. In brackets: cases of investigations formerly undertaken outside the CONECOFOR programme. Note: individual investigations may have covered only part of the 1996-2005 period. Details about the nature of the various investigations are provided by PETRICCIONE and POMPEI (2002), FERRETTI (2000) and FERRETTI *et al.* (2003, 2006)
*Categorie di indagini condotte presso le aree permanenti del programma CONECOFOR. Tra parentesi: indagini iniziate prima dell'incorporazione nella rete CONECOFOR. Nota: alcune indagini possono non avere coperto l'intero periodo 1995-2005. I dettagli sulla natura delle varie indagini sono riportati da PETRICCIONE e POMPEI (2002), FERRETTI (2000) e FERRETTI *et al.* (2003, 2006).*

PMP no.	Code	Site data	Tree cond.	Soil chem.	Foliage chem.	Forest structure tree growth	LAI	Litterfall	Ground vegetation	Deposition chem.	Ozone meas.	Meteo meas.	Remote sensing	Lichens	Deadwood	Insects	Naturalness	Landscape
1	ABR1	+	+	+	(1)	+	+	+	+	+	+	+	+					+
2	BAS1	+	+	+	+	+	+	+	+		+	+	+					
3	CAL1	+	+	+	+	+	+	+	+	+		+	+		+	+		
4	CAM1	+	+	+	+	+	+	+	+	+		+	+					
5	EMI1	+	+	+	+	+	+	+	+	+	+	(3)	+		+			
6	EMI2	+	+	+	+	+	+	+	+	+	(2)	+	+					
7	FRI1	+	+	+	+	+	+	+	+	+	+	(3)	+					
8	FRI2	+	+	+	+	+	+	+	+	+	(2)	+	+		+			+
9	LAZ1	+	+	+	(1)	+	+	+	+	+	(2)	+	+					
10	LOM1	+	+	+	+	+	+	+	+	+	+	+	+		+			+
11	MAR1	+	+	+	+	+	+	+	+	+	+	+	+					
12	PIE1	+	+	+	+	+	+	+	+	+	(2)	+	+					
13	PUG1	+	+	+	+	+	+	+	+	+	+	(3)	+					
14	SAR1	+	+	+	+	+	+	+	+	+	+	(3)	+		+	+		
15	SIC1	+	+	+	+	+	+	+	+	+	+	+	+		+	+		
16	TOS1	+	+	+	+	+	+	+	+	+	+	(3)	+		+			+
17	TRE1	+	+	+	+	+	+	+	+	+	+	+	+		+			+
18	UMB1	+	+	+	+	+	+	+	+	+	+	+	+					+
19	VAL1	+	+	+	+	+	+	+	+	+	+	(3)	+					
20	VEN1	+	+	+	+	+	+	+	+	+	+	+	+		+			
21	ABR2	+	+			+									+	+		+
22	LAZ2	+	+			+												+
23	LOM2	+	+		(+)	+				+								
24	LOM3	+	+			+				+								
25	TOS2	+	+		(+)	+	+	+	+	+					+			+
26	TOS3	+	+		(+)	+	+	+	+	+								
27	BOL1	+	+		(+)	+	(+)	(+)	+	+							+	+
28	LIG1	+	+		(+)	+			+	+								
29	PIE2	+	+															
30	PIE3	+	+							+								
31	VEN2	+	+															

(1) plus soil solution chemistry
(2) plus streamflow chemistry
(3) plus SO₂

2000, FERRETTI *et al.* 2003, 2006)

As concerns the biodiversity issues, a specific report prepared by the Italian Forest Service (CONECOFOR Board) has been published by the European Environment Agency (Forest Status Indicator, PETRICCIONE *et al.* 2007).

Changes in concerns and legal framework

The effects of atmospheric pollution, and particularly of atmospheric deposition, on forests was of major concern at the beginning of programme. This reflected the situation at European level. A first element of change was that in Italy ozone was incorporated in the monitoring activity since the very beginning in 1996. It makes now possible to analyse the trend of ozone concentrations over a 10 years period and the CONECOFOR has already produced a national thematic report on ozone (FERRETTI *et al.* 2003), as well as reports about international projects (FERRETTI *et al.* 2004; BUSSOTTI and FERRETTI 2007).

The diversity of vascular species and of the forest

structure were incorporated in the monitoring since 1996. However, biodiversity activity has increased since 2003, with the start of new surveys on invertebrates, lichens, deadwood and naturalness and the consideration of the landscape perspective. During this test-phase (PETRICCIONE 2004), a high value for nature conservation was discovered: community interest or priority habitats and species occur on 8 out of 12 plots, according to the Habitat Directive (EEC) n. 92/43. This activity has allowed a report to be published by 2006 (FERRETTI *et al.* 2006).

In the early 2000s, priorities of CONECOFOR activities were re-oriented towards national and international projects and initiatives with the final aim to establish a pan-European network for biodiversity monitoring. These initiatives aim at the assessment of progress towards the target of halting (or reducing) the loss of biodiversity by 2010, as requested by the UN Convention on Biological Diversity, the UN Framework Convention on Climate Change (both ratified by Italy in 1994) and the EU policy instruments for their implementation, like the EU Commission Communica-

tion COM(2006)216 (European Commission 2006) and the EEA SEBI2010 process (Streamlining European Biodiversity Indicators by 2010, EEA 2006). With entering into force of EC Regulation no. 2152/2003 Forest Focus, these new priorities found an EU legal basis for co-funding the related pilot projects, developed at trans-national level in the field of forest biodiversity monitoring: (i) *ForestBIOTA*, a joint project carried out in 2004-2005 by 12 European Countries, based on 107 EU/ICP Forests Level II permanent plots, collecting data on four main biodiversity indicators in a standardized way (BFH 2004) and (ii) *BioSoil*, a joint project undertaken in 2006-2007 by 21 European Countries, based on ca. 4000 EU/ICP Forests Level I systematically placed plots, collecting data on three main biodiversity indicators in a standardised way (JRC 2006).

Very recently, in the frame of the EEA programme SEBI2010, a specific forest qualitative indicator, taking into account status and trends of key characteristics of forest ecosystems, has been developed by the Italian Forest Service (Forest Status Indicator, FSI, PETRICCIONE 2007; PETRICCIONE *et al.* 2007). FSI is based on sub-indicators identified and implemented at pan-European and national level, such as tree condition, forest structure, deadwood, plant species composition and naturalness, mostly available at European level and collected according to harmonized methods (EU pilot projects *ForestBIOTA* and *BioSoil*, EU Forest Focus & UN/ECE ICP Forests and ICP IM, National Forest Inventories). Changes in time and “distance” from a defined target or other reference values can be easily recognized by the change in shape of the applied “radar” diagrams (Figure 3).

Perspectives

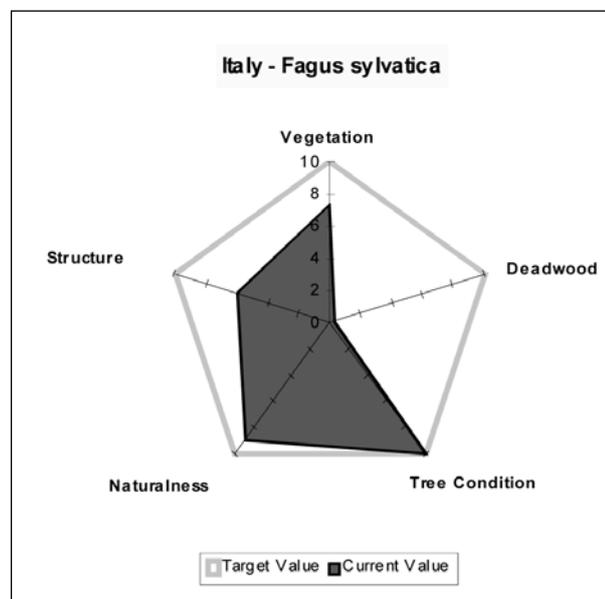
Extending co-operation and shifting from monitoring to research

In 2004 the Italian Forest Service (CONECOFOR Board) joined the *ALTER-Net* Network of Excellence (A Long-Term international research Network on ecosystems, for action and awareness on biodiversity, ALTER-Net 2007), a large EU co-funded consortium of 24 research bodies from 17 EU Member States. ALTER-Net aims to (i) develop an integrated a pan-European Long-Term Ecological Research Network; (ii) develop appropriate research following harmonized methods in the field of biodiversity and climate change

and (iii) develop methodological tools for improving public awareness and European policies as concerns biodiversity protection.

The participation to ALTER-Net gave to Italy the opportunity to become official member of the International Long Term Ecological Research Network (ILTER) in 2006. A long lasting both scientific and organizational process, starting in the 1990s at national level, brought Italy to get to that important objective. Through communication issues, selection criteria and activities, several researchers and scientists coming from public Agencies, Universities and research Institutions were involved in order to spread information about the initiative and search for suitable research sites to be included in the Network. A managing structure for the Network was created: the National Forest Service (CONECOFOR Board) was involved in the LTER-Italy Network start up since the very beginning as well and is even now in charge for the national overall co-ordination. During 2005, through several internal meetings, the national Steering Committee of the Network started to analyse the proposed sites and the ongoing research activities within them. In 2006 a rank list of Italian sites was produced. Among those, suitable sites were finally selected with the scientific revision of external experts: at the moment, LTER-Italy consists of an integrated group of 17 sites

Figure 3 – Examples of polar diagram based on same sub-indicators of Forest Status Indicator (from PETRICCIONE *et al.* 2007).
Esempio di diagramma polare basato sugli stessi sotto-indicatori del Forest Status Indicator (da PETRICCIONE et al. 2007).



developing long-term ecological research. Admitted sites represent all main ecosystem types (forest, freshwater, marine, alpine, *etc.*). Sites are linked each other by ecological and bio-geographical similar traits and may include more than one research station. Four sites include forest environments (“Forests of the Alps”, “Forests of the Apennines”, “Mediterranean forests” and “Lowland forest”): 10 research stations (plots) belong to the CONECOFOR Level II network (BREDEMEIER *et al.* 2007; CORPO FORESTALE DELLO STATO 2007a).

Integration among monitoring networks

Alongside the development of the Level II network (see above), two major processes took place. Firstly, 240 Level I sampling “points” have been transformed into “plots” (2500 m²), through the recent implementation of the pilot project *BioSoil*. Secondly, there is an ongoing process of integration between Level I and the National Forest Inventory (NFI), the latter being based on a probabilistic sampling design. A trend towards an integration among the three networks (Level I, Level II, NFI) is being developed. In this framework, a re-organization of the Level II network will be implemented, selecting 11 very intensive “integrated monitoring core sites” (with even more intensive and additional surveys at larger scale), 11 “Level III sites” (with all “traditional” surveys implemented) and 9 “regular” Level II plots.

Seeking for new funding routes

The specific EU co-funding legal tools in the field of forest monitoring were not extended over the end of 2006, the deadline of the last dedicated EC Regulation no. 2152/2003 Forest Focus. CONECOFOR is now going to apply to the new EC Regulation no. 614/2007 concerning the Financial Instrument for the Environment LIFE+. The CONECOFOR board decided to participate in some proposals: two at International level, one national. At the international level, CONECOFOR is leader in the *FutDiv* proposal (Future Forest Biodiversity Monitoring in Europe) and an associated beneficiary in the *FutMon* proposal (Further Development and Implementation of an EU-level Forest Monitoring System). At national level, CONECOFOR is associated beneficiary in the FORCLIMATE proposal (Atmospheric Drivers and Forest Response to Climate along Nitrogen and Ozone Gradients - Reliability of Model Predictions).

In particular, the *FutDiv* proposal has been submitted with the aim to include a harmonized system for long-term biodiversity monitoring and to provide prompt responses to the requirements of the EU policies for the implementation of the UN Convention on Biological Diversity. Italy will be the leading Country of 14 Member States, including National Forest Inventories (NFIs), Level I and Level II networks, IM and LTER sites all over Europe (CORPO FORESTALE DELLO STATO 2007b).

This report

On the basis of the data collected over the period 1995-2005, this report aims to investigate if, and at what extent, changes that invariably occur in our forests ecosystems are somewhat directional. The various papers will cover the analysis of data derived from the biological components of the ecosystems (tree condition, growth and mortality; species richness and diversity), the chemical characteristics (deposition chemistry, soil solution chemistry, tropospheric ozone), and the meteorological measurements. Further information will cover the changes at landscape level. An integrated evaluation will be developed, attempting to summarize the actual results of changes in individual attributes. In the final chapter, a synthesis will be provided.

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