



LIFE 11 ENV/IT000215

Resilienza delle Foreste Mediterranee
ai cambiamenti climatici

Resilience of Mediterranean Forests
to Climate Change

GUIDA AL PROGETTO

PROJECT GUIDE

RESILIENZA DELLE FORESTE MEDITERRANEE AI CAMBIAMENTI CLIMATICI

RESILIENCE OF MEDITERRANEAN FORESTS TO CLIMATE CHANGE



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Questo lavoro è dedicato alla memoria di Sebastiano Cullotta, che ha contribuito in modo sostanziale allo sviluppo e alla realizzazione del progetto ResilForMed, con grande competenza scientifica, passione personale e dedizione.

La sua profonda conoscenza dei boschi siciliani è stata fondamentale per lo sviluppo delle azioni di studio e di intervento nel territorio, il suo spirito forestale determinante per l'interpretazione dei risultati.

A lui va il nostro ringraziamento e il nostro pensiero.

This work is dedicated to the memory of Sebastiano Cullotta, which has substantially contributed into the development and implementation of the ResilForMed project, with his great scientific expertise, personal passion and dedication.

His deep knowledge of the Sicilian forests, has been fundamental for the development of study actions and for the intervention in the territory; his forestry spirit has been determinant for the interpretation of the results.

Our thanks and thought are for him.

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REGIONE SICILIANA
Dipartimento dello Sviluppo
Rurale e Territoriale



**UNIVERSITÀ
DEGLI STUDI
DI PALERMO**

Dipartimento Scienze Agrarie,
Alimentari e Forestali



**CORPO FORESTALE
DELLA REGIONE SICILIANA**

A cura di - *Edited by*

Sebastiano Sferlazza

 www.orcid.org/0000-0002-1333-7417

Donato Salvatore La Mela Veca

 www.orcid.org/0000-0003-0921-0103

Marcello Miozzo

Federico Guglielmo Maetzke

 www.orcid.org/0000-0001-5688-0420

Responsabili del progetto

Project superintendents

Luciano Saporito

Olimpia Campo

Coordinatore tecnico del progetto

Project technical coordinator

Marcello Miozzo

Responsabili scientifici del progetto

Project scientific superintendents

Federico Guglielmo Maetzke

Donato Salvatore La Mela Veca

Sebastiano Sferlazza

Esperti forestali

Forestry experts

Giuseppe Clementi, Paolo Contrino,

Giuseppe Traina, Salvatore Vinciguerra,

Ivana Fantoni, Stefano Bracciotti,

Antonio Consoli, Remo Bertani,

Gaetano La Placa

Esperti ornitologi

Ornithology experts

Guido Tellini Florenzano, Guglielmo Londi,

Tommaso Campedelli, Simonetta Cutini

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Responsabile Unico del Procedimento

Proceeding Sole Supervisor

Mara Fais

Elaborazione grafica e assistenza alla stampa

Graphic design, DTP and press assistance

Palermo University Press



2 Forests in Sicily

Federico Guglielmo Maetzke, Donato Salvatore La Mela Veca, Sebastiano Sferlazza
Dipartimento Scienze Agrarie, Alimentari e Forestali – Università degli Studi di Palermo

Sicily is the widest island in the Mediterranean and the biggest of Italian regions with a surface of 25,711 Km². The region includes, besides the main island, also some minor islands: the Eolie archipelago, the Egadi archipelago, the Pelagie archipelago, the islands of Pantelleria and Ustica. The island is characterized by a high variety from the geological, lithological, pedological, climatic, vegetational, historical and cultural point of view. The island is the expression of its millenary history and of the centuries-long action of different peoples and cultures which shaped its landscape and contributed to its extraordinary bio-diversity. The average annual rainfall amounts to 680 mm, going from 400 mm in southern Sicily and sub-coastal plains, to 1600 mm at the higher altitudes of the main island's mountains. The average annual temperature

is 16.4 °C, going from 18-20 °C along the coasts, to 8-10°C on mountain tops [1].

The traditional Sicilian landscape is characterized by agricultural systems (extensive cultivations, previously cultivated areas), grazing, meadowlands and shrublands. Forest formations are few and linked to the island's mountains. They are mainly placed within the Regional Natural Parks (Etna, Madonie, Nebrodi, Sicani and Alcantara), within the Pantelleria National Park as well as in the protected areas of the Natura 2000 network. Apart from native formations, there are also wide surfaces covered by artificial forest populations formed by conifers and broadleaf trees.

In Sicily the first reliable forests census, dating back to 1861, reported a forest surface of 110,000 hectares, 98,000 hectares in 1911, 87,000 hectares in 1929; the high-

est deforestation level was recorded during World War II [2]. In the 1950s, the Sicilian Region places the forests qualitative and quantitative reconstruction at the first place of its social and environmental policy through two main tools: planting new forests and improving the existing ones. Today, Sicily with its 274,454 hectares of forests is one the Italian regions with the lowest tree density coefficient, about 10.6%, and the total forest surface amounts to 512,121 hectares (considering also the other woody lands). The following surface figures refer to the Sicilian Region Forests Inventory [2].

The Sicilian forests have been classified according to a hierarchical system where the base unit is the Forest Type which can be divided into subtypes and variants; similar types are grouped into superior hierarchical units called Forest Categories [3]: i) the **Forest Category** is a physiognomic unit, usually defined on the base of the domination of one or more building tree or shrub species and corresponding to comprehensive vegetation units normally used in silviculture (chestnut forests, beech forests, holm oak forests, etc.); ii) the **Forest Type** is the classification main unit. It is homogeneous from the floristic, station, dynamic trends and silvicultural-management points of view; the name includes some ecological, structural, and sometimes even floristic significant and distinguishing features; iii) the **Subtype** is by definition a unit subordinate to the Forest Type, differing from this one for some ecological and floristic variations due to substrata stands differences (acidophilic or basophilic subtype), meso-microclimatic differences linked to hygro-thermic parameters (Inferior and superior subtype) and evolution dynamics (primary or secondary forests); iv) within a Type or a Subtype, the Variant is characterized by a clear variation in the composition of the

tree layer compared to the prevailing Type composition, without any alteration of the undergrowth. Hereafter follows a general description of the 14 Sicilian forest categories.

Holm-oak forests (*Quercus ilex* L.)

Holm-oak forests represent the potential vegetation of great part of Sicilian coastal and sub-coastal reliefs and they cover 28,650 hectares, corresponding to 6% of the overall forest surface. The altitude limits of this Category go from sea level to 1300-1500 m a.s.l., coming into contact with the mountain forests (Downy oak and Beech forests).

They are almost pure coenoses, locally mixed with downy oaks and other broadleaf deciduous trees. 4 forest types can be found, because of their capability to colonize different environments together with very different vegetal communities.

The structural forms are quite different. The dominating stands are difficult to define, they are represented by several coppices left free to evolve (or which have undergone to sporadic and irregular cuttings during the last decades). They have produced mixed stands, with coppices and high forests, where the two components are difficult to discern, while high forests represent about 15%.

Cork oak forests (*Quercus suber* L.)

These formations cover 18,830 hectares from the sea level up to 500 m a.s.l., mainly on the island's northern (Madonie and Nebrodi) and south-eastern (Iblei) reliefs, colonizing the siliceous and volcanic substrata, and producing coenoses mixing with other broadleaf trees (downy and holm oaks), shrubs and Mediterranean pine trees. The Cork oak stand structure is of forest-maquis type, with an open canopy dominated by the cork oak

wide and spherical crown often dominating a close shrubby layer. Cork-oaks are usually dominated in the silvo-pastoral systems in many areas of Sicily, where trees are exploited to produce cork or firewood, while the shrubby and herbaceous layer is used in grazing.

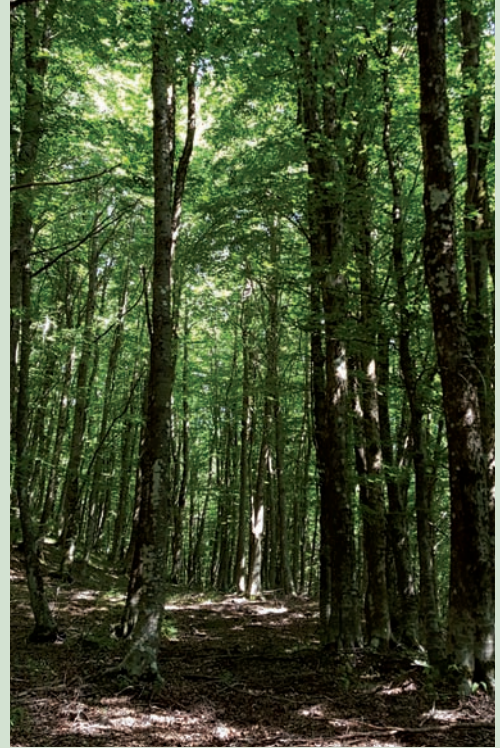
Downy oak forests

Forests with sessile oaks (*Quercus petraea* (Matt.) Liebl) and downy oaks (*Quercus pubescens* Willd.) cover almost 85,000 hectares (about 17% of the regional forest surface); the downy oak is the most widespread of the two species, while the sessile oaks represent about 2%. The sessile oak forests are almost completely concentrated in the central part of the Madonie mountains, on more or less acid substrata, at different altitudes, between 1200 and 1500 m. On the other side, the downy oak forests cover an area going from the sea level up to 1200 m a.s.l., coming into contact with the Beech forests.

Downy oak forests have almost always been managed as coppices to produce charcoal and firewood (practices today almost disappeared). For these reasons, their structure can be considered, in the first place as overstood coppices, and in second place as high forests.

Turkey oak Forests (*Quercus cerris* L.)

Turkey oak forests cover 25,289 hectares, almost exclusively concentrated on the Nebrodi Mts. Their widest distribution is on the Tyrrhenian sea side where Turkey oaks can be found from 400m up to 1300 m a.s.l.; while, towards the inland the distribution area gets thinner and moves upwards, even at altitudes higher than 1500 meters. This



category includes a thermophilic and a mesophilic forest type: the first type refers to a Sicilian endemic species, the Gussone Oak (*Quercus gussonei* (Borzi) Brullo) only present on the Nebrodi Mts. and in the Ficuzza wood. The presence of uncontrolled grazing and the competition with shrublands represent the main risk factors for the natural Turkey oak regeneration.

Beech forests (*Fagus sylvatica* L.)

The Sicilian beech forests cover an area of 15,964 ha and they are particularly important from the phytogeographic and ecological point of view as they grow in the most southern part of the European distribution area for this species. In Sicily the Beech tree characterizes the island's montane landscape; it grows between 1200 and 2000 m of altitude, covering the most important Ma-

donie and Nebrodi mountain tops or reaching the treeline highest limit (on Mt. Etna, together with the Corsican Pine and the endemic birch). This category includes four forest types linked to different substrata (calcareous, siliceous, volcanic). From the structural point of view, within the Sicilian beech forests, overstood coppices prevail, then there are the forest grounds evolving into high forests (about 11%). Highly concentrated, but very interesting at the same time, are high forests (just 9%) in general mono-layer.

Chestnut forests (*Castanea sativa* Mill.)

Chestnuts cover an area of about 11,500 ha (2.3% of the regional forest surface). Their altitude limits go on average from 400-500 m of altitude, mainly on the eastern Nebrodi and western Peloritani Thyrrenian reliefs, to 1200-1400 m on the eastern and southern sides of Mt. Etna, where they get in touch, sometimes producing mixed stands, with the beech, the Corsican pine, the downy oak and the poplar. In thermophilic areas, they join with the holm-oaks and the other more thermophilic deciduous oaks. As for the structure, the great majority of chestnut forests is made up of overstood coppices (about 65%); stands having a high-forest structure are only 11%. Top-soils identified as mixed forests are less than 10%.

Orno-Ostrietum forests

These formations include two main species, the Manna-ash (*Fraxinus ornus* L.) and the European hop-hornbeam (*Ostrya carpinifolia* Scop.), very limited relict coenoses, covering about 100 ha, on Mts Nebrodi and Mt. Etna. This category includes a xerophilous and a meso-xerophilous type. These two species

are almost completely represented by structures hardly imputable to standard and regular management forms (coppices or high forest); actually, in the great majority of cases, they are forests under no management because of stand conditioning (low mountainsides, impluvia, gorges) where the presence of buds is often caused by natural shocks on stumps. Only in accessible stands it is possible in most cases to trace a structure back to more or less overstood coppices.

Riparian formations

This category includes mainly meso-hygrophilous and meso-xerophilous forest populations, typical to impluvia, more or less pebbly riverbeds, often characterized by the presence of one or more co-dominant species; they are sometimes ephemeral and erratic coenoses whose presence is strictly connected to the river dynamics. These stands cover 19,177 ha, that is 3.7% of the regional forest surface. This category includes five forest types, divided according to their physiognomically dominant species.

Pioneer vegetation

This category includes heterogeneous forest populations as for composition, structure and evolution-cultivation set up. In most cases, they invade free areas, produced by natural disorders or human actions, abandoned cultivation areas, or rocky stands. They are xerophilous and meso-xerophilous coenoses spreading from the sea level to all the mountain area and cover about 4,500 ha. Their distribution is both linked to particular site and environmental conditions (soil surface, rocky areas, erosion phenomena, frequent fires), and to the progressive discontinuance of agricultural practices. The category includes

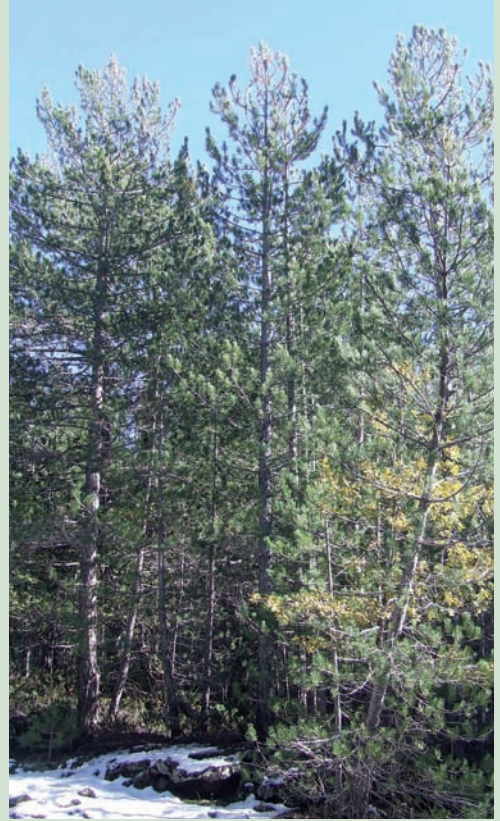
seven forest types for the high variability in specific species composition, structure, and evolutionary dynamics.

Mediterranean pine forests

This category comprises natural formations of Aleppo pine (*Pinus halepensis* Mill.), maritime Pine (*Pinus Pinaster* Ait.) and stone pine (*Pinus pinea* L.), it includes 4 forest types covering an overall surface of 2,245 ha. They are spontaneous native pine forests; they can be pure or mixed with other tree or shrub species typical to the native vegetation. They also include the naturalized Aleppo pine and stone pine forests, in different growing stages, which originated from natural regeneration of adjacent reforestations or from natural regeneration following a burned reforestation.

Corsican pine forests (*Pinus nigra* ssp. *laricio* [Poir.] Mair)

The Corsican pine forests cover an area of 4,316 ha from 1000 up to 2000 m a.s.l. along the western and eastern sides of Mt. Etna. This category includes 3 forest types, forming xerophilous and meso-xerophilous coenoses, according to ecological (altitude, substratum, bioclimate) and human factors. From a structural point of view, these pine forests can be identified as pure mono-layer high-forests for about 60%; while 37% are high forests with more articulated structures, where native broadleaf trees become a part of. Deciduous oaks are generally part of the Corsican pine forests composition at lower altitudes (below about 1500m), often producing two-layer structures where the oaks lower layer shows a replacement dynamic (from a pine forest towards the deciduous meso-xerophilous oak forest). At higher alti-



tudes, the mix with the trembling poplar, Etna birch and beech, becomes more and more important; in this case too, the presence of mixed two-layer structures of pine and beech trees shows an evolution dynamic going towards a beech forest.

Plantations

These formations cover 105,460 ha, that is 21% of the total forest surface, from the sea level up to the higher mountain horizon. This category includes all conifers and broadleaf artificial plantations started at the end of the '800s and good part of the '900s, to create protections against hydrogeological phenomena and to create the conditions to easily spread again the natural wood species. These plantations have been performed



mainly on abandoned public properties, and secondly on private ones. In terms of composition, reforestations involve; *Eucalyptus* ssp., Mediterranean conifers (e.g. *Pinus halepensis* Mill., *Pinus Pinea* L., *Pinus pinaster* Ait., *Cupressus* ssp., *Cedrus* ssp.). While, on mountainous and sub-mountainous areas, the most used species have been the black pine and the Corsican pine, cedars, sometimes mixed with the Greek fir, douglas fir and other mountain broadleaf trees (for example, *Acer pseudoplatanus* L.).

In general, the reforestation structure is mainly mono-layer (in particular within eucalyptus forests), where the dominant layer is made up of wooden species; in the second place, it can be a two-layer structure (in many conifers plantations). Density varies according to the evolution stage, the implementa-

tion of a previous silviculture (thinning and other cultivation practices) and to the impact of adverse phenomena (pathogens or fires); in the great majority of cases, density can be from dense to very dense; it is quite always still visible the regular structure (in rows) of the original installation. The broadleaf trees, in natural succession or intentionally introduced, can be generally found in the lower layer; only in a few cases they take part to the constitution of the dominant layer, they often form regeneration groups, more rarely with a regular distribution. Two-layer stands are more frequent on the mountain area where native oak trees regenerate and establish.

Mediterranean shrublands

They are coenoses both of primary and steady origin and of secondary origin (from invasion or from degraded maquis-forest stands), characterized by the holm-oak presence. These coenoses cover the whole region, with a surface of almost 108,572 ha, that is 21% of the regional forest surface. It is a heterogeneous category as for its composition; it includes 8 forest types, characterized mainly by one or more woody species and by parameters like height, potential and evolution dynamics. Evergreen and Mediterranean summer-deciduous species prevail. They succeed in growing in the driest and poorest Mediterranean areas. The most widespread species are: *Spartium junceum* L., *Pistacia lentiscus* L., *Calicotome infesta* (C. Presl) Guss., *Rhus* ssp., *Euphorbia* ssp., *Juniperus* ssp., *Cistus* ssp., *Quercus ilex* L., *Quercus calliprinos* Webb., *Olea europaea* var. *sylvestris* (Miller) Lehr, *Chamaerops humilis* L.

Their habitat is of great interest at Community level thanks to their high naturalistic value and for their contributions to biodiversity.



Supra-Mediterranean shrublands

They are coenoses both of primary and steady origin and of secondary origin (from invasion or decay of degraded soils). But they are all pioneer broadleaf coenoses, able to colonize more or less open areas very quickly. These coenoses cover a surface of 30,730 ha in the Island's supra- and oro-Mediterranean belt. It is a very heterogeneous category for its composition; it includes 5 forest Types, going from xerophilous to mesophilous coenoses, colonizing different substrata (calcareous, siliceous, volcanic). The most

represented species are: *Erica arborea* L., *Ilex aquifolium* L., *Prunus* spp., *Rosa* spp., *Crataegus* spp., *Pyrus* spp., *Genista aetnensis* Raf., *Cytisus scoparius* (L.) Link.

These shrubby formations perform many functions, giving an important contribution to the mountainsides protection from erosion caused by weather precipitations, re-creating the ecological conditions in favour of the spontaneous regeneration of the forest cover; they offer an effective contribution to biodiversity and provide food and shelter to wild fauna. ■

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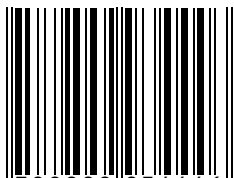


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