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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

D.R.E.AM.
ITALIA

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
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Giuseppe Traina, **Salvatore Vinciguerra**,
Ivana Fantoni, **Stefano Bracciotti**,
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Mara Fais

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3.2
Analysis, assessment and quantification of the climate changes impact: the resilience silvicultural indicators

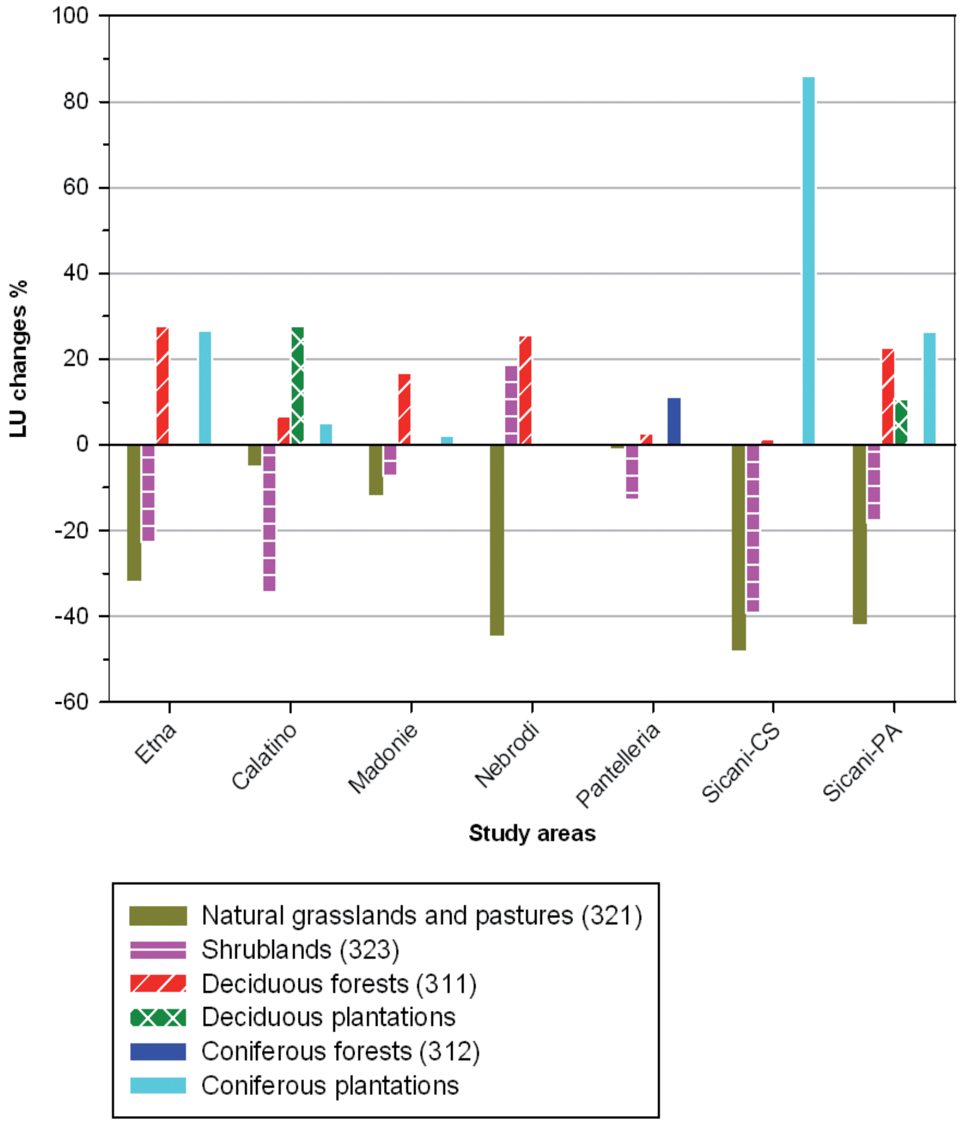
Federico Guglielmo Maetzke, Donato Salvatore La Mela Veca, Sebastiano Sferlazza
Dipartimento Scienze Agrarie, Alimentari e Forestali – Università degli Studi di Palermo

In order to analyze, assess and quantify the main effects of the climate change over the forest ecosystems (Action A3), a monitoring system has been devised both through diachronic surveys on the main forest and pre-forest landscape systems of Island and through the comparison of historical data related to sampling surveys on species and habitats with current data obtained through photo-interpretation of recent cartographic supports. In order to produce the information stratas, the photo-interpretation in a GIS environment of remote sensed images has been used, concerning four historical moments: 1955, 1968, 1988, 2012. With reference to the years 1955 and 1968, black and white aerial photos have been used (flights IGM 1955, 1968), black and white orthoimages for the year 1988 (flight 1988-89 - the National Geoportal – Ministry of the Environment and of Sea and Territory Safeguard), while, for the years 2007-2012 satellite images have been used (Bing Maps, Microsoft Corporation). The integration of different sources, as for origin, scale and acquisition techniques, required, first of all, the digitalization of the aerial photos so to make them usable in a GIS environment and the normalization of all the iconic sources according to the international reference system UTM, zone 33S, with geographic coordinates referred to the international ellipsoid WGS84, so to make the different information stratas comparable. This work followed the following steps:

- Classification of the land use (LU) of the study areas through extraction (clip) in a GIS environment of the information quoted in the Regional Forest map [1]. For the non-forested areas, that is not included in the above map, the photo-interpretation has been used, assigning a code representing the soil class of use according to the classification CORINE Land Cover III level;
- Validation of the soil classes of use identified, and updating of the information stratum to 2012 through the Bing Maps;
- Classification of the historical land use (through stereoscopical photo-interpretation of aerial photos concerning the years 1955-1968 and of 1988 orthoimages);
- Quantification of the land cover (LC) of forest surfaces in the years 1955, 1968, 1988, 2012;
- Arrangement of a geodatabase for the land use and land cover changes concerning the considered years.

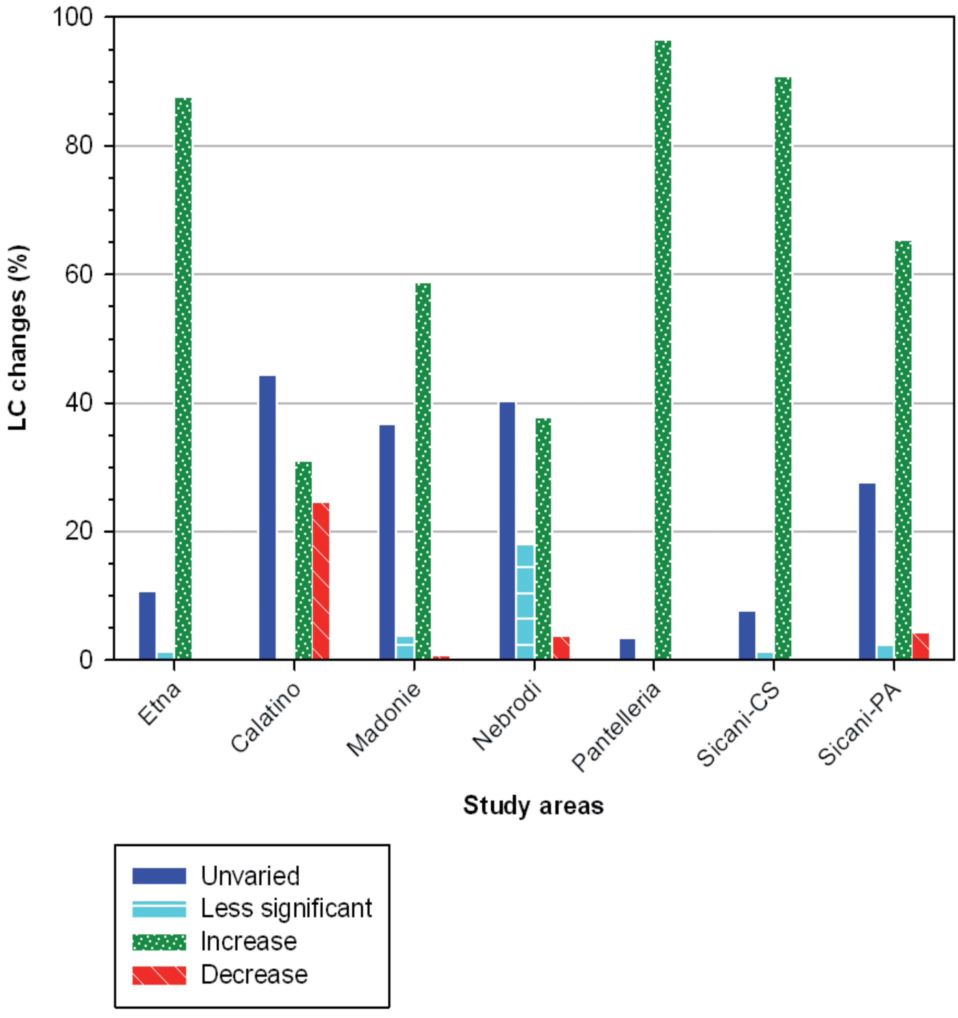
Through these actions it has been possible to classify and quantify land use and land cover changes in these areas along the time, taking into account both the whole period (1955-2012) and the intermediate periods (1955-1968, 1968-1988, 1988-2012). Land use changes have been classified into three classes [2]: “unvaried”, if no change has been recorded; “evolution”, where some successional dynamics have been recorded increasing the forest ecosystems structural complexity and/or composition; “degradation”,

Fig. 3.2.1 **Dynamics of the land use (LU) changes (%) in the period 1955- 2012 [2]**



includes all those forest formations which have undergone an obvious simplification in the structure and/or composition. Land cover changes have been classified into four classes [2]: "unvaried"; "less significant", when a change equal to or below 20% has been observed; "increase" and "decrease", when an increase or a decrease in the cover degree above 20% has been recorded. The 20% value has been used as the minimum threshold to consider the increase or decrease variations in the land cover significant. As to the

Fig. 3.2.2 Dynamics of the land cover (LC) changes (%) in the period 1955-2012 [2]



land use, the greatest variations have been observed in the study areas of Etna, Calatino and Sicani Mts., while in the other study areas less significant changes have been recorded (Fig. 3.2.1).

In particular, the changes in the land use observed in the areas of Mt. Etna, Madonie and Nebrodi Mts. are due to the successional dynamics of natural vegetation, while they are due to afforestation activities in the Sicani Mts. and Calatino areas. With reference to land cover changes, an increase has been recorded in all the study areas (Fig. 3.2.2).

An important increase in the land cover, above 50%, has been observed in the Pantelleria maritime pine forests, on the Etna Mt, on Sicani and Nebrodi Mts. The only significant decrease in the cover degree, equal to 25%, has been recorded in the Calatino area.

With reference to Action A4, concerning the definition of the role of communities and ecosystems in the adaptations strategies to climate change, an extensive field campaign was set up on the unvaried areas, where no LULC change had occurred in the period 1955-2012.

Formations referable to 12 forest types and to 8 forest categories have been surveyed [3] in order to establish a list of resilience silvicultural indicators considered effective in maintaining resilience and capability to adapt to climate change [4].

The resilience silvicultural indicators can be used for different purposes: i) to describe and assess the forests condition; ii) to identify stress and disturbance factors within the forests; iii) to assess the effects of the forest management on the stand features (density, specific composition, structure, etc.) and to outline the future dynamics. The selected resilience silvicultural indicators are:

- Tree composition;

- Forest crown cover;

- Dendrometric parameters: tree density (n ha^{-1}), basal area (G, in m^2 ha^{-1}), mean diameter (Dm, in cm), mean height (Hm, in m), stem volume (V, m^3 ha^{-1}); for each forest type it has been estimated the minimum level required to maintain the resilience and adaptive capacity of forests of every parameter for each forest type investigated (Tab. 3.2.1);

- Structural diversity: vertical and horizontal distribution;

- Presence/absence of sporadic and/or endemic tree species;

- Presence/absence of old-growth trees;

- Presence/absence of natural regeneration: composition, density, limiting factors;

- Presence/absence of dead wood: volume and decay classes;

- Presence/absence of hydrogeological instability phenomena.

During the sampling activities, the sporadic and/or endemic tree species have been recorded too [4]. These species represent an important element of biodiversity and resilience within Sicilian forests; therefore, it is necessary to protect them and foster their greater presence and spreading. The list of the identified sporadic and endemic tree species is in Tab. 3.2.2. ■

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Link: https://www.researchgate.net/profile/Sebastiano_Sferlazza

Tab. 3.2.1 **Minimum level of main dendrometric parameters required to maintain the forest resilience [4]**

Forest category		Species	Tree density (n ha^{-1})	Basal area (m^2 ha^{-1})	Dm (cm)	Hm (m)	V(m^3 ha^{-1})
Category	**Forest type**						
Downy oak forests	*Quercus pubescens* forest of xeric environments	*Quercus pubescens Willd.*	1241	19	14	7	98
Cork oak forests	*Quercus suber* forest of xeric environments	*Quercus suber L.*	573	9	14	5	29
Holm oak forests	Mountain *Quercus ilex* forest of carbonatic substrata	*Quercus ilex L.*	608	30	25	13	169
	Quercus ilex forest of xeric environments, variant of volcanic substrata	*Quercus ilex L.*	477	13	19	11	70
Turkey oak forests	*Quercus cerris* forest tipica	*Quercus cerris L.*	1050	28	18	14	168
Beech forests	*Fagus sylvatica* forest tipica on calcareous substratum	*Fagus sylvatica L.*	4042	36	11	10	207
	Fagus sylvatica forest tipica on siliceous substratum	*Fagus sylvatica L.*	1750	36	16	10	220
Corsican pine forests	*Pinus laricio* forest tipica	*Pinus nigra ssp. laricio (Poir.) Mair*	859	38	24	14	287
Mediterranean pine forests	*Pinus pinaster* forest	*Pinus pinaster Ait.*	2896	55	16	10	356
Plantations	*Eucalyptus* plantation tipica	*Eucalyptus camaldulensis Dehnh.*	827	19	17	12	105
	Eucalyptus plantation, variant mixed with Mediterranean evergreen species	*Eucalyptus camaldulensis Dehnh.*	198	7	21	12	36
	Pinus halepensis plantation	*Pinus halepensis Mill.*	198	28	42	16	257

Tab. 3.2.2.1 **List of the sporadic and endemic tree species identified in the surveyed Sicilian forests [4]**

Scientific name	Common name (in Italian)	Endemic	IUCN Red List
Acer monospessulanum L.	Acero minore	-	-
Acer obtusatum Willd et K.	Acero etneo	-	-
Acer pseudoplatanus L.	Acero di monte	-	-
Betula aetnensis Raf.	Betulla dell'Etna	Sicilia, Mt. Etna	-
Carpinus orientalis Miller	Carpino orientale	-	-
Celtis tournefortii subsp. asperrima (Lojac.) Raimondo & Schicchi	Bagolaro dell'Etna	Sicilia, Mt. Etna	Vulnerable (VU)
Celtis australis L.	Bagolaro	-	-
Ceratonia siliqua L.	Carrubbo	-	-
Cercis siliquastrum L.	Albero di Giuda	-	-
Fraxinus angustifolia subsp. oxycarpa (Willd.) Franco & Rocha Afonso	Frassino meridionale	-	-
Genista aetnensis (Raf. ex Biv.) DC.	Ginestra dell'Etna	Sicilia, Mt. Etna; Sardegna	-
Ilex aquifolium L.	Agrifoglio	-	-
Malus sylvestris Miller	Melo selvatico	-	-
Ostrya carpinifolia Scop.	Carpino nero	-	-
Pinus nigra subsp. laricio Poiret	Pino laricio	Sicilia, Mt. Etna; Calabria	Vulnerable (VU)
Pistacia terebinthus L.	Terebinto		
Prunus avium L.	Ciliegio	-	-

Tab. 3.2.2.2 **List of the sporadic and endemic tree species identified in the surveyed Sicilian forests [4]**

Scientific name	Common name (in Italian)	Endemic	IUCN Red List
Prunus mahaleb L. subsp. cupaniana (Guss.) Arc.	Ciliegio canino di Cupani	Sicilia	Vulnerable (VU)
Pyrus spinosa Forssk.	Pero mandorlino	-	-
Pyrus castribonensis Raimondo, Schicchi & Mazzola	Pero di Castelbuono	Sicilia, Monti Madonie	Vulnerable (VU)
Pyrus pyraster (L.) Burgsd	Pero selvatico	-	-
Pyrus sicanorum Raimondo, Schicchi & Marino	Pero sicano	Sicilia, Monti Sicani	Endangered (EN)
Pyrus vallis-demonis Raimondo & Schicchi	Pero di Valdemone	Sicilia, Monti Nebrodi	Endangered (EN)
Sorbus aria (L.) Crantz	Sorbo montano	-	-
Sorbus aucuparia L.	Sorbo selvatico	-	-
Sorbus aucuparia L. subsp. praemorsa (Guss.) Nyman	Sorbo degli uccellatori	Sicilia, Sardegna, Corsica	Vulnerable (VU)
Sorbus domestica L.	Sorbo domestico	-	-
Sorbus graeca (Spach) Kotschy	Sorbo meridionale	-	-
Sorbus torminalis L. (Crant)	Ciavardello	-	-
Taxus baccata L.	Tasso	-	-
Tilia platyphyllos Scop.	Tiglio nostrale	-	-
Ulmus glabra Hudson	Olmo montano	-	-
Ulmus minor Mill.	Olmo minore	-	-
Ulmus minor subsp. canescens (Melville) Browicz & Ziel.	Olmo canescente	-	-
Zelkova sicula Di Pasquale, Garfi & Quézel	Zelkova siciliana	Sicilia, Monti Iblei	Critically Endangered (CR)

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