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SCIENCE

Phytosociological survey vegetation map of Sicily (Mediterranean region)

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ABSTRACT

We present the results of a study aimed at developing a vegetation map of Sicily (Italy) including the smaller circum-Sicilian islands, for an area of approximately 25,703 km². The work is a synthesis of studies carried out in accordance with the survey methodology of phytosociology in the last 40 years over the whole study area. *The vegetation map of Sicily* was compiled in a Geographical Information Systems (GIS) environment, in order to produce a cartographic representation at a scale of 1:10,000 (reduced to a scale of 1:250,000). The physiognomic-structural characteristics of the plant landscape of Sicily are analyzed, providing a general and, at the same time, detailed overview of the phytocoenotic aspects represented on the territory, as well as of the relative bibliographic references. At the reference scale, 36 types are represented, 16 of which are related to zonal vegetation (Mediterranean maquis, *Quercus ilex* woods, *Quercus suber* woods, *Castanea sativa* woods, *Quercus pubescens* deciduous woods, mesophilous deciduous woods, *Fagus sylvatica* woods, *Betula aetnensis* woods, woods dominated by woody gymnosperms, forest edge shrubs, orophilous pulvinate shrubs, shrublands and garrigues, *Ampelodesmos mauritanicus* grasslands, mesophilous and sub-hygrophilous grasslands and pastures), 11 are related to azonal vegetation (riparian, psammophilous herbaceous, chasmo-halophitic, etc.) and 9 are related to anthropogenic vegetation (arable lands and extensive herbaceous crops, vineyards, olive groves and dry cultivation mosaics, hazelnut groves, irrigated citrus groves and orchards, greenhouses, built-up areas).

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Sicily; phytosociology; vegetation map; GIS; habitat conservation; Mediterranean region

1. Introduction

Vegetation maps – produced at different scales (1:50,000, 1:25,000 and 1:10,000), according to the degree of detail – represent phytocoenoses and provide useful qualitative-quantitative assessments of biological resources in a specific area (Pedrotti, 2004). In preliminary studies for land planning and management, they represent important summary documents, whose graphic design is now performed through Geographic Information Systems (GIS), often applying the survey methodology of Phytosociology (Biondi, 1996; Biondi & Calandra, 1998; Biondi et al., 2007; Rivas-Martínez, 2005). This paper provides an example of this methodology by compiling a map at a scale of 1:250,000, based on a field survey at a scale of 1:10,000. The surveyed area is Sicily, the largest Mediterranean island (25,432 km²), including its smaller islands (the archipelagos of the Aeolian, Aegadian and Pelagie Islands, Ustica and Pantelleria islands), for a total area of 25,703 km².

The study is the result of years of research in the area and gives an overview of the extensive phytosociological-cartographic literature on this territory produced in the last 40 years. Some of the main incentives of this research are related to two important laws concerning Sicily: (1) the Regional Law 98/1981, which led to the establishment of 5 natural parks (Mt. Etna,

Madonie Mts., Nebrodi Mts., Sicani Mts. and Alcantara River) and over 70 natural reserves; (2) the Habitats Directive 92/43/EEC, which led to the identification of 234 Natura 2000 sites (205 Sites of Community Importance [SCIs], 15 Special Protection Areas [SPAs], 14 SCIs and SPAs).

The vegetation map of Sicily is a useful synthesis of the regional plant landscape, whose complexity and variety reflect the large physiographic, lithological, geomorphological and bioclimatic variability of the territory. Moreover, this landscape has been affected by human activity, within an area in the centre of historic and cultural events that have characterized the civilization of the whole Mediterranean region.

2. Study area

Sicily is in the central part of the Mediterranean Sea, separated from the Italian Peninsula by the Strait of Messina and washed by the Ionian Sea (eastward), the Tyrrhenian Sea (northward) and the Channel of Sicily (southward), which separates Sicily from Africa (Figure 1). The small circum-Sicilian islands are the Aeolian Islands (northeastward), the Ustica Island (northwestward), the Aegadian Islands (westward), the Pantelleria Island (southwestward) and the Pelagie Islands Lampedusa and Linosa (further south).



Figure 1. Framework of Sicily and its smaller islands in the Mediterranean region.

The landforms of the northern part of Sicily are characterized by mountains that, from east to west, include the Peloritani, the Nebrodi, the Madonie, Palermo and Trapani mountains. The central-southern and south-western parts – with the exception of the Sicani Mountains – show a different landscape, with lower heights and hills. The central-eastern part is dominated by the volcanic cone of the Mt. Etna, southwards of the Peloritani Mountains, whereas the south-eastern part is dominated by the Hyblean Mountains plateau.

The geological history of Sicily is linked to that of a large area of the Mediterranean Sea, characterized by extreme tectonic mobility, mostly defined by sedimentary rocks deposited in different paleogeographic domains, subject to tectonic vicissitudes from the Upper Palaeozoic to the Quaternary. On the basis of petrographic, sedimentological and textural characteristics, and stratigraphic and structural setting, the geological formations of Sicily can be grouped in various lithological complexes (Lucchesi, 2004), which can be summarized as follows: *Continental deposition clastic Complex* (alluvial deposits, sometimes terraced; coastal, lacustrine and marsh deposits; slope accumulations); *Volcanic Complex* (Mt. Etna, ancient volcanics of the Hyblean Mts., Aeolian, Ustica and Linosa islands); *Clayey-marly Complex* (Pleistocene clays, mid-Pliocene blue clays, marls with foraminifera of the lower Pliocene, clayey and marly formations of the middle-upper Miocene, pelitic lithofacies of Flysch deposits, brecciated clays and varicoloured clays);

Evaporitic Complex ('Gessoso-Solfifera' Formation of the Upper Miocene, characterized by Tripoli, sulphur limestones, gypsum and salts); *Conglomerate-sandstone Complex* (terrigenous lithofacies of the mid-upper Miocene); *Sandstone-clayey-calcareous Complex* (flyschoid formations with a predominant sandstone composition, mainly spread in the northern sector of Sicily); *Carbonate Complex* (calcareous, calcareous-dolomite and dolomite formations, aged between Mesozoic and Tertiary, which constitute the structure of the Apennine-Maghrebian Sicilian chain, present on the heights of the northern part of Sicily and in the Hyblean area); *Phyllitic and shale-crystalline Complex* (metamorphic basement of the Peloritani Mts.).

According to the classification of Rivas-Martínez (1985), the territory is divided into the following six bioclimatic belts (Brullo & Spampinato, 1990): (1) *Inframediterranean* (annual average temperature: 18–20°C), along the southern slopes of some small islands in the extreme south (Lampedusa, Linosa, Pantelleria) and of Sicily itself; (2) *Thermomediterranean* (annual average temperature: 16–18°C), circumscribing the coastal and sub-coastal belt of the various insular areas; (3) *Mesomediterranean* (annual average temperature: 13–16°C), spread over most of the hilly-submountain areas of Sicily and also in the higher parts of some small islands, such as Pantelleria, Marettimo and Salina; (4) *Supramediterranean* (annual average temperature: 8–13°C), on the highest peaks of the Sicani, the Madonie, the Nebrodi, the Peloritani Mts.

and of Mt. Etna; (5) *Oromediterranean* (annual average temperature: 4–8°C) and (6) *Crioromediterranean* (annual average temperature: 2–4°C), characteristic of the summit of Mt. Etna.

Regarding rainfall, the area is divided into the following regions: *semi-arid* (annual average rainfall < 350 mm per year), limited to the Pelagie Islands and some short coastal stretches in the southern part of Pantelleria; *dry* (annual average rainfall = 350–600 mm), typical of the coastal and sub-coastal belt of Sicily and of the smaller islands; *sub-humid* (annual average rainfall = 600–1000 mm), which includes hilly and submountain areas of Sicily, the peaks of Pantelleria, Marettimo and some Aeolian islands (Salina, Vulcano); *humid* (annual average rainfall > 1000 mm), on the highest peaks of the Madonie, the Nebrodi, the Peloritani Mts. and of Mt. Etna); *hyperhumid* (annual average rainfall > 1950 mm), limited to the highest part of Mt. Etna.

The biogeographic classification by Rivas-Martínez, Penas, and Diaz (2004) puts Sicily in the Holarctic Kingdom, Mediterranean region, western Mediterranean Subregion, Italo-Tyrrhenian Province and Sicilian Subprovince, within which Brullo, Minissale, Signorello, and Spampinato (1996) distinguish two sectors (in turn divided into subsectors and districts), according to the following scheme: (1) Eu-Sicilian Sector (Sicily, Ustica, Aeolian and Aegadian islands): (a) north-eastern Subsector (Aeolian, Madonie, Nebrodi, Peloritani and Etna districts); (b) western Subsector (Aegadian and drepano-panormitano districts); (c) central Subsector (Agrigento and Catania districts) and (d) southern Subsector (Hyblean and camarino-pachinense districts); (2) Pelagic Sector (Pantelleria and Pelagie islands): Pelagic Subsector (cosyrense, alagusico and lopadusano districts).

3. Methods

The drafting of the *Main Map* required several phases: (1) preparation of a GIS project aimed at creating a 1:10,000 scale graphic, with a comprehensive database, implementing the various thematic layers with georeferenced documents (according to the Gauss-Boaga coordinate system in kilometers); (2) photo-interpretation of the vegetation through digital color orthophotos (programme 'IT 2000TM', carried out throughout the country by the 'Compagnia Generale di Riprese aeree' of Parma, flight MAE 2007, flight Agea 2007, flight ATA0708 RPA, Perugia, Italy, scale 1:20,000) and satellite images in color (Landsat TM, Google Earth 25 cm pixels), with digital data on the Technical Map of Sicily in 1:10,000 scale (published for the Sicilian Region in 2002, and subsequent updates); (3) cross-checks of various other information layers (maps published for Sicily on vegetation, land use, geology, soil science and bioclimatology); (4) validation of the photo-interpretation of the identified

phytocoenotic types, through field survey and verification; (5) digitizing of the results and additional data; (6) phytosociological characterization of the mapped types and preparation of the legend; and (7) production of the final *Main Map* in 1:250,000 scale, graphic definition and final version printing.

Figure S1 is a schematic lithological map of Sicily (from Fierotti, Dazzi, & Raimondi, 1988, redrawn), including the smaller circum-Sicilian islands. Figures S2 and S3 show the thematic maps, respectively, of the annual average temperatures and rainfall of the region, produced on the basis of climate data from the Regional Hydrographic Service covering the 1965–1994 period (Drago, 2005).

The phytosociological characterization complies with the methodological criteria of the Sigmatista School of Zurich-Montpellier (Braun-Blanquet, 1932). The syntaxonomic definition of the coenoses was carried out by examining the extensive bibliography related to the area (Gianguzzi & Minissale, 2007), whose references are reported in the text and in the supplemental materials. In particular, publications aimed at cartographic surveys at the 1:10,000/1:25,000 scale, concern the following areas: Mt. Etna (Poli, Maugeri, & Ronsisvalle, 1983), Capo Passero Island (Pirola, 1965), Mt. Cofano (Barbagallo, Brullo, & Guglielmo, 1980; Gianguzzi & La Mantia, 2008), Linosa Island (Brullo & Piccione, 1980), Pietraperzia (Brullo, Fagotto, Lo Cicero, & Piccione, 1980), Vendicari (Brullo, Fagotto, & Marcenò, 1980), Piano Battaglia on the Madonie Mts. (Raimondo, 1980), Filicudi Island (Longhitano, 1983), Parco della Favorita (Buffa, Venturella, & Raimondo, 1986), Mt. Carcaci Nature Reserve (Gianguzzi, Spennati, & La Mantia, 2007), Pantelleria Island (Gianguzzi, 1999; Gianguzzi & La Mantia, 2002a), Mt. Pellegrino Nature Reserve (Gianguzzi, Ilardi, & Raimondo, 1996; Surano, Gianguzzi, & Raimondo, 1996), Torre Salsa Nature Reserve (Cammalleri, Gianguzzi, Ilardi, & Sortino, 1996), Bauli on the Hyblean Mts. (Costanzo, Furnari, Scelsi, & Tomaselli, 1996), Sughereta di Niscemi (Costanzo, Furnari, & Tomaselli, 1996), Bosco Ficuzza, Rocca Busambra, Bosco del Cappelliere and Gorgo del Drago Nature Reserve (Gianguzzi, 2004; Gianguzzi & La Mantia, 2004; Gianguzzi, La Mantia, & Rigoglioso, 2004), Monte delle Rose (Gianguzzi, La Mantia, & Marchetta, 2001), Vallone Calagna Nature Reserve (Gianguzzi & La Mantia, 2002b; Gianguzzi, La Mantia, & Lo Presti, 2004), Marettimo Island (Gianguzzi, Scuderi, & La Mantia, 2003), Levanzo Island (Romano, Tobia, & Gianguzzi, 2006), Pizzo Cane, Pizzo Trigna and Grotta Mazzamuto Nature Reserve (Gianguzzi, Caldarella, & La Mantia, 2005), Isola Bella and the surrounding area (Minissale, Sciandrello, & Spampinato, 2005; Sciandrello, D'Agostino, & Minissale, 2013), 'Torre Manfria' SCI at Gela (Guarino, Minissale, & Sciandrello, 2008), 'Capo Murro di Porco, Penisola

della Maddalena e Grotta Pellegrino' SCI at Siracusa (Minissale, Santo, & Sciandrello, 2011). Other cartographic studies in scale 1:50,000 affected larger areas, including the carbonate massif of the Madonie Mts. (Raimondo, Gianguzzi, & Schicchi, 1994), the Province of Palermo (Raimondo et al., 2000) and the south-eastern part of the Sicani Mts. (Marino, Castellano, Bazan, & Schicchi, 2005). Further contributions for the regional area equipped with smaller scale maps were published by Tomaselli, Gentile, Pirola, and Balduzzi (1968), Pedrotti et al. (1992), Raimondo, Gianguzzi, Venturella, and Lo Valvo (1992), Geomap (1995) and Blasi (2010), in addition to other phytosociological and cartographic surveys – some of which are unpublished – promoted by the Sicilian Region (Department of Territory and Environment).

The syntaxonomical framework refers to that reported in the Prodrómo della vegetazione d'Italia (<http://www.prodrómo-vegetazione-italia.org/>), except some specific references in the text and in the supplemental materials.

4. Results

The results obtained through photo-interpretation and field validation allowed the identification of 36 phytocoenotic types, divided in zonal (communities tied to the various bioclimatic belts, in particular maquis, woods, garrigues and semi-natural grasslands), azonal (coenoses typical of habitats conditioned by the substrate, such as cliffs, streams, coastal dunes, etc.) and anthropogenic vegetation (artificial forest plantation, cultivated land, built-up areas and other habitats affected by human activities). The various types are described in detail in the supplemental materials, following the order of the Main Map legend as shown in Table 1.

5. Conclusions

An overview of the mapped types, including their extent, divided between the territory of Sicily and its smaller islands, is given in Table 1. The plant landscape is complex and varied, characterized by 36 phytocoenotic categories, in which anthropogenic types prevail; in fact, in addition to the urbanized areas (buildings and out-buildings, with an area of 125,064 ha), most of the territory is covered by 'cultivated lands and temporary fallow lands' (846,470 ha), followed by 'Olive groves and other dry crops' (336,528 ha), 'Citrus groves and irrigated orchards' (158,592 ha), 'vineyards' (142,558 ha), 'greenhouses' (15,608 ha) and 'Hazel groves' (12,411 ha). In addition to these vegetation aspects, there are also artificial plantations dominated by non-native species, in particular by *Pinus halepensis* and other conifers (57,681 ha) and by *Eucalyptus camaldulensis* and/or

other broad-leaved species (42,145 ha); these plantations were set up during the last century – especially in Sicily, and to a lesser extent on its smaller islands – in order to promote the recovery of the woodlands reduced by human activity.

On the basis of the cartographic analysis, natural wood communities occupy a total area of 174,296.72 ha (equal to about 6.78%), of which 172,736.71 ha is in Sicily and 1560 ha in the smaller islands, mainly in hilly and mountain areas, as well as along streams and rivers. In particular, they are 'deciduous woods of the *Quercus pubescens* group and other deciduous species' (94,111 ha), '*Quercus ilex* woods' (22,561 ha), '*Quercus suber* woods' (21,482 ha), '*Fagus sylvatica* woods' (16,285 ha) and '*Betula aetnensis* woods' (361 ha), 'thermophilous and mesophilous coniferous woods' (7963 ha), 'riparian and dwarf woods, with prevalence of *Salix* sp. pl., *Populus* sp. pl. and *Platanus orientalis*' (overall 32,322 ha), 'dwarf woods of xeric river terraces with *Tamarix* sp. pl. and/or *Nerium oleander*' (15,404 ha).

Other phytocoenotic units of naturalistic and landscape importance are represented by shrubs and garrigues, usually present on the margins of wooded areas, divided into: (a) 'shrublands on forest edges with predominance of thorny and deciduous species' (35,717 ha); (b) orophylous cushion-like shrubs, spread on the Madonie Mts. and Mt. Etna (5398 ha); (c) 'shrubs and garrigues on rocky ridges and eroded slopes of carbonate nature' (13,857 ha) and (d) 'shrubs and garrigues on rocky ridges and eroded slopes of silicate nature' (78,147 ha).

Other secondary units widespread both in Sicily and in the smaller islands are the Mediterranean grasslands, with an overall area of 330,039 ha; these are herbaceous communities, used for grazing and regularly affected by wildfires, that characterize large parts of the landscape of the hilly and submountain belts.

Units of azonal vegetation are also numerous and varied across the territory, represented by 'pioneer glareicolous communities of river gravel beds' (6125 ha), 'psammophilous communities of sandy coastal stations' (3174 ha), 'chasmo-halophilous communities on sea cliffs with predominance of *Crithmum maritimum* and *Limonium* sp. pl.' (2132 ha), 'halophilous communities of lagoons, salt flats and brackish marshes' (3174 ha), 'halo-nitrophilous communities of badlands areas' (14,439 ha), 'hygro-hydrophilous communities of freshwater lakes' (14,496 ha), 'chasmophytic communities of rocky cliffs, including quarry areas and lithic outcrops' (11,138 ha) and 'lava flows and naked lava fields or with sparse vegetation' (16,415 ha).

Thus, the plant landscape of the area is largely anthropogenic, and reflects intense use since ancient times of this important territory situated in the centre of the Mediterranean area. The natural aspects are limited to relatively small 'natural oasis', whose biotopes

Table 1. Phytocoenotic types surveyed and their extent in Sicily and in the smaller islands.

Code	Synthetic description	Total area (ha)	Sicily area (ha)	Smaller islands (ha)
1	Mediterranean maquis (cl. <i>Quercetea ilicis</i> , ord. <i>Pistacio-Rhamnetalia alaterni</i>)	21,415.94	18,333.93	3082.01
2	<i>Quercus ilex</i> woods (cl. <i>Quercetea ilicis</i> , ord. <i>Quercetalia ilicis</i>)	22,561.29	21,417.81	1143.47
3	<i>Quercus suber</i> woods (cl. <i>Quercetea ilicis</i> , ord. <i>Quercetalia ilicis</i>)	21,482.58	21,482.58	–
4	<i>Castanea sativa</i> woods (cl. <i>Quercu roboris-Fagetea sylvaticae</i>)	11,539.43	11,518.96	20.47
5	Deciduous woods of the <i>Quercus pubescens</i> gr. and other deciduous species (classes: <i>Quercetea ilicis</i> , <i>Quercu roboris-Fagetea sylvaticae</i>)	68,753.96	68,750.23	3.74
6	Deciduous woods with prevalence of other oaks (cl. <i>Quercu-Fagetea sylvaticae</i>)	25,348.73	25,348.73	–
7	<i>Fagus sylvatica</i> woods (cl. <i>Quercu roboris-Fagetea sylvaticae</i>)	16,285.17	16,285.17	–
8	<i>Betula aetnensis</i> woods (cl. <i>Quercu roboris-Fagetea sylvaticae</i>)	361.62	361.62	–
9	Coniferous woods: (a) thermophilous pinewoods with <i>Pinus halepensis</i> or <i>Pinus pinaster</i> subsp. <i>hamiltonii</i> ; (b) mesophilous woods with <i>Taxus baccata</i> or <i>Pinus nigra</i> subsp. <i>calabrica</i>	7963.94	7571.61	392.33
10	Shrublands on forest edges with predominance of thorny and deciduous species (cl. <i>Rhamno-Prunetea</i> , ord. <i>Pyro spinosae-Rubetalia ulmifolia</i>)	35,717.07	35,696.93	20.14
11	Orophyllous cushion-like shrubs (Madonie Mountains and Mt. Etna)	5398.14	5398.14	–
12	Shrubs and garrigues on rocky ridges and eroded slopes of carbonate nature (cl. <i>Rosmarinetea officinalis</i>)	13,857.16	12,243.93	1613.22
13	Shrubs and garrigues on rocky ridges and eroded slopes of silicate nature (cl. <i>Cisto-Lavanduletea</i>)	78,147.16	72,832.88	5314.28
14	Grasslands of the xeric-mediterranean belt (classes <i>Lygeo-Stipetea</i> and <i>Artemisietea vulgaris</i>) with: (a) <i>Hyparrhenia hirta</i> ; (b) nitrophilous-ruderal species; (c) <i>Brachypodium retusum</i> ; (d) pioneer species of badlands areas; (e) <i>Arundo collina</i>	145,004.02	142,027.39	2976.63
15	Grasslands of the submountain belt (cl. <i>Lygeo-Stipetea</i>), with predominance of <i>Ampelodesmos mauritanicus</i>	103,282.47	103,259.41	23.06
16	Mesophilous and sub-hygrophilous grasslands of the submountain and mountain belts (classes: <i>Festuco valesiacae-Brometea erecti</i> , <i>Molinio-Arrhenatheretea</i>)	152,713.86	15,1210.14	1503.72
17	Dwarf woods of xeric river terraces, coastal and sometimes inland (cl. <i>Nerio-Tamaricetea</i>), with <i>Tamarix</i> sp. pl. and/or <i>Nerium oleander</i>	15,404.83	15,404.83	–
18	Riparian and dwarf woods of the submountain and mountain river stretches, with prevalence of <i>Salix</i> sp. pl. (cl. <i>Salicetea purpureae</i>) and <i>Populus</i> sp. pl. (cl. <i>Salici purpureae-Populetea nigrae</i>)	13,793.41	13,768.94	24.48
19	Riparian woods with predominance of <i>Platanus orientalis</i> (cl. <i>Salici purpureae-Populetea nigrae</i>)	3125.19	3125.19	–
20	Pioneer glareicolous communities of river gravel beds	6125.78	6121.29	4.49
21	Psammophilous communities of sandy coastal stations (classes: <i>Cakiletea</i> , <i>Ammophiletea</i> , <i>Helichryso-Crucianelletea maritima</i>)	3174.76	3120.81	53.96
22	Chasmo-halophilous communities on sea cliffs with predominance of <i>Crithmum maritimum</i> and <i>Limonium</i> sp. pl. (cl. <i>Crithmo maritimi-Staticetea</i>)	2132.29	1055.66	1076.63
23	Halophilous communities of lagoons, salt flats and brackish marshes (classes: <i>Ruppiaetea</i> , <i>Thero-Suaedetea</i> , <i>Juncetea maritimi</i> , <i>Sarcocornieteae fruticosae</i>)	3174.42	3142.57	31.85
24	Halo-nitrophilous communities of badlands areas (classes: <i>Saginetea</i> , <i>Lygeo-Stipetea</i> , <i>Pegano-Salsoletea</i>)	14,439.44	14,433.53	5.91
25	Hygro-hydrophilous communities of freshwater lakes (classes: <i>Charetea</i> , <i>Lemneteae minoris</i> , <i>Potametea pectinati</i> , <i>Phragmito-Magnocaricetea</i> , etc.)	14,496.89	14,496.21	0.68
26	Chasmophitic communities of rocky cliffs, including quarry areas and lithic outcrops (classes: <i>Asplenietea trichomanis</i> , <i>Parietarietea judaicae</i> , <i>Anomodonto-Polypodietea</i>)	11,138.78	10,857.67	281.12
27	Lava flows and naked lava fields or with sparse vegetation	16,415.09	15,910.80	504.28
28	Plantations with predominance (codominance) of <i>Pinus halepensis</i> and other conifers	57,681.10	56,796.87	884.22
29	Plantations with predominance (codominance) of <i>Eucalyptus camaldulensis</i> and/or other broad-leaved species	42,145.92	42,137.55	8.37
30	Cultivated lands and temporary fallow lands (cl. <i>Stellarietea mediae</i>)	846,470.20	845,948.17	522.03
31	Vineyards (cl. <i>Stellarietea mediae</i>)	142,558.83	140,386.99	2171.83
32	Olive groves and other dry cultural aspects (cl. <i>Stellarietea mediae</i>)	336,528.59	332,899.29	3629.29
33	Hazel groves	12,411.27	12,411.27	–
34	Citrus groves and irrigated orchards (cl. <i>Stellarietea mediae</i>)	158,592.85	158,559.34	33.51
35	Greenhouses	15,608.46	15,608.46	–
36	Buildings and out-buildings	125,064.91	123,318.57	1746.34
	Total (ha)	2,570,315.54	2,543,243.47	27,072.07

fall within protected areas, nature parks and reserves, as well as SCIs (Sites of Community Importance) and SPAs (Special Protection Areas), sparse both in Sicily and in the smaller islands.

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Disclosure statement

No potential conflict of interest was reported by the authors.

Software

All cartographic work was carried out using the Esri ArcGIS 9.1/10 and Adobe Illustrator CS4. Field data were collected using a Garmin E-Map GPS, with processing by Map Source.

Supplemental data

Supplemental data for this article can be accessed 10.1080/17445647.2015.1094969

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