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Predicting Woody Plant Diversity as Key Component of Ecosystems:
A Case Study in Central Greece

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ABSTRACT

The Mediterranean basin is a global hotspot of biodiversity. Woody plants are key components of ecosystems. This article explores the environmental impacts on woody plant species richness and diversity in maquis and abandoned olive groves in an important ecological area of central Greece. The results showed that woody plant species richness and diversity had increasing values in maquis compared to abandoned olive groves. According to Principal Component Analysis, woody plant species richness and diversity (Shannon diversity index) were positively correlated with soil organic matter, plant litter, N, P, K, slope and precipitation in maquis. Also, positive correlations among woody plant species richness and diversity, and soil organic matter, and slope were detected in abandoned olive groves. Conclusively, the present study is the first in the area and the results it will be utilized as a decision support tool for sustainability assessment of ecosystems with the help of the information systems.

KEYWORDS

Abandoned Olive Groves, Biodiversity, Canoco, Distribution Pattern, Environment, Information Systems, Maquis, Principal Component Analysis

1. INTRODUCTION

The Mediterranean basin region is a global hotspot of biodiversity and presents a wide diversity of habitats and ecosystems. Biodiversity is a widely used term in ecology and natural resource management, and it is a key item in nature conservation (Do et al., 2015; Feroz et al., 2016).

Greece is distinguished for its rich flora. The country is geographically located in SE Europe and occupies the southern tip of the Balkan Peninsula (the farthest east of the three peninsulas of Europe), which, unlike the other two, doesn't have the very high mountains separating it from the rest of Europe. It is an inland country with a large number of islands and is close to Asia and Africa. Also, it contains a variety of climatic conditions (29 climatic classes according to the Thornwaite classification scheme), a fact attributable to its geographic location, terrain ruggedness and the presence

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of the sea. The vascular plants of Greece include 5758 species and 1970 subspecies, representing 6620 taxa, belonging to 1073 genera and 185 families. Many of these plant species are endemic, as a result to the location and the particular climatic, geological and topographical conditions (Dimopoulos et al., 2013).

Land abandonment constitutes a characteristic element of people's dynamic relationship with natural ecosystems. In the Mediterranean region, which has undergone anthropogenic intervention for thousands of years (Kosmas et al., 2000), there has been dramatic abandonment of traditional land uses, agriculture and livestock farming over the past decades. Land abandonment may be due to natural causes or socio-economic factors (Lambin & Meyfroidt, 2010). Due to the dramatic decline in land productivity over the last decades, areas that have been introduced into cultivation in the past century are increasingly being abandoned (Karakosta, 2012; Kosmas et al., 2000).

According to Lambin & Meyfroidt (2010), socio-economic causes seem to be the most important cause of land abandonment. Naveh & Kutiel (1989), Lepart & Debussche (1992) and Cramer et al. (2007) refer that the environmental and socio-economic changes of recent decades have led to dramatic abandonment of the countryside resulting in the abandonment of cultivated land throughout the world. The abandonment of land is due to socio-economic factors that force the rural population to move from the countryside to large urban centers (Macdonald et al., 2000; Bonet & Pausas, 2004; Papanastasis, 2008; Karakosta, 2012).

MacDonald et al. (2000) report that the abandonment of agricultural land is due to a lack of profit in agricultural activity, the inability to adapt to new farming practices due to the small agricultural pieces of land and the natural aging of the active agricultural population. Several studies (Lavorel et al., 1998; Lavorel et al., 1999; McIntyre et al., 1999) point out that the estimation of the effects of external factors on vegetation, such as abandonment, can be investigated with the assistance of plant functional groups.

Woody plant species are among the most important components of terrestrial ecosystems (e.g. maquis and abandoned olive groves) and affect the overall composition of their communities and environment (Paganová & Jureková, 2012; Solomou & Sfougaris, 2015). Especially, they offer food such as leaves, flowers, pollen, nectar, seeds, and fruit which are important for the wildlife diets (Solomou & Sfougaris, 2015). In addition, woody plant species diversity is fundamental to the overall natural ecosystems biodiversity, because woody plants provide habitats for almost all other species (Feroz et al., 2016). Also, structural diversity measured as variation across a vertical stand profile appears to be a good ecological indicator of the conservation of woody species diversity (Feroz et al., 2016; Neumann & Starlinger, 2001).

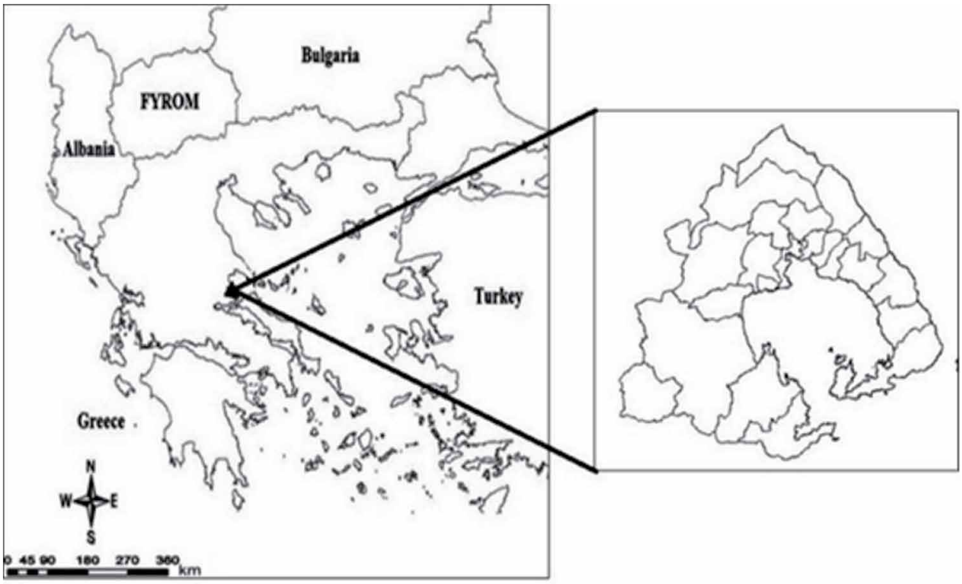
The main aims of the present study are to provide primary information on: a) woody plant composition and diversity in maquis and abandoned olive groves, an important area with high conservation value and b) environmental impacts on woody plant species richness and diversity (Shannon diversity index) so as to generate data that would be used in the future management of these ecosystems.

2. MATERIALS AND METHODS

2.1. Study Area

The study was conducted in 2009 on 10 maquis (M1-M10), a shrubland biome in the Mediterranean region, and 10 abandoned olive groves (A1-A10) in western Magnesia Prefecture of Central Greece (Figure 1). The Magnesia Prefecture is located in the south-eastern part of Thessaly and consists of a continental section, the islands of Northern Sporades, as well as some uninhabited smaller islands and rocky islets. It has a total area of 2.638 km^2. Bordering from the south with the Fthiotida Prefecture, NW with the Larissa Prefecture, east with the Aegean Sea and SE with the Pagasitic Gulf. A large part of the county is mountainous (45%).

Figure 1. Study area (Western Magnesia, Central Greece)



The study area contains a variety of agricultural ecosystems (pasture, olive groves, abandoned olive groves and annual crops) and natural forest/shrub vegetation near the agricultural areas. It is included in the *Quercetalia ilicis* vegetation zone, and *Quercion ilicis* and *Oleo–Ceratonion subzones* (Figure 2). The rocks in most of the area are marrakech shale, foliage and gneiss as well as marbles, while limestone rocks and flysch are presented sporadically. The climate is typical Mediterranean with dry and warm summers and mild winters with mean annual air temperature of 16.8°C and mean annual rainfall of 490 mm (Figure 3) (Hellenic National Meteorological Service of Greece, 2010).

The Mount Pelion, and Mavrovouni and Karla reservoirs, Ormos Sourpi and the Mount Goura have been designated as Important Bird Areas (IBA). Mavrovouni is also designated as SPA (Special Protected Area), in accordance with Directive 79/409/EEC on the conservation and protection of

Figure 2. Vegetation map of study area (G: evergreen broad-leaved species, Altitude:0-600 m)

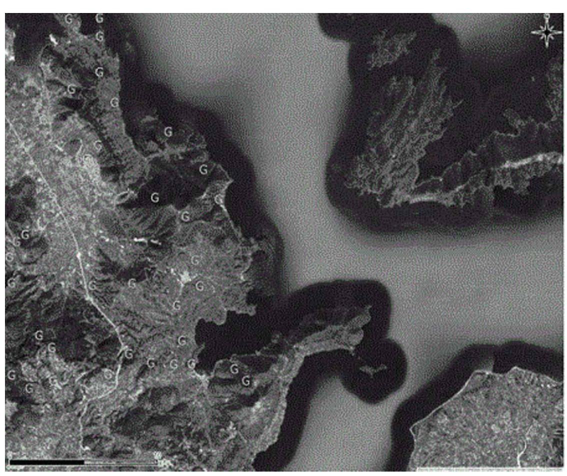
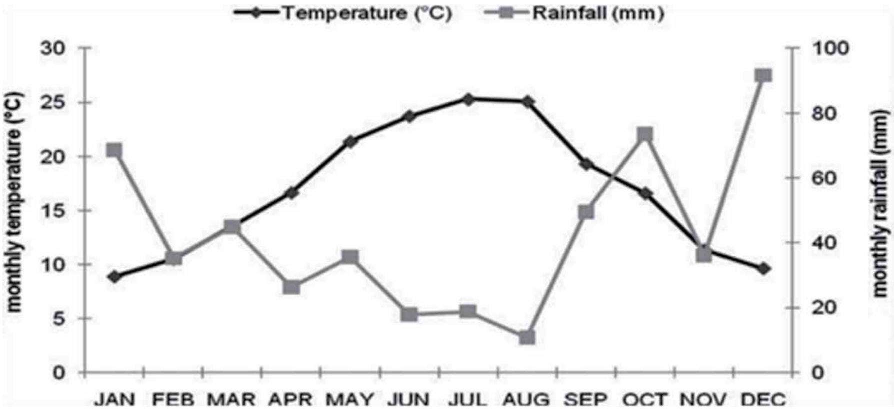


Figure 3. Ombrothermic diagram of the study area for the period 1956–2010 (data from Hellenic National Meteorological Service of Greece 2010)



wild birds in Europe. Finally, according to the Corine Biotopes Project, the Mount Pelion (12.000 ha), Ormos Sourpi - Stomio of Magnesia (1.300 ha), Kouri (120 ha) and Goura Mountains (7.500 ha) have been identified as important biotopes (YPEXODE, 1998).

2.2. Sampling and Statistical Analysis

Woody vegetation was surveyed in May 2009. Sampling was carried out in selected plots of 100 m^2 (10 m×10 m) (Koutsidou, 1995) in 10 maquis and 10 abandoned olive groves (abandoned for about 12 years). Collins Tree Guide was used for the identification of woody plant species (Johnson & More, 2004). Also, in each type of ecosystem (maquis and abandoned olive groves), five soil samples were randomly taken (0–30 cm deep) and mixed to obtain one representative sample (10 soil samples in maquis and 10 in abandoned olive groves). More specifically, soil samples thus prepared were analyzed for soil pH (SPH) (McLean, 1982), organic matter (OM) (Nelson & Sommers, 1982), N (Bremner & Mulvaney, 1982), P (Olsen & Sommers, 1982), and K (Thomas, 1982). Additionally, soil plant litter (SPL) was recorded by visual estimation. Air humidity (AH) (%) and temperature (AT) (∘C), and precipitation (PR) (mm) were estimated by Hellenic National Meteorological Service. Finally, altitude (ALT) (m) and slope (SL) (%) were recorded using a global positioning system (GPS; e-Trex Vista, Garmin, Olathe Kansas) and a clinometer (Suunto Tandem), respectively.

Moreover, diversity indices such as species richness, Shannon Wiener, Simpsons D, Margalef D, McIntosh D, Brillouin D, Fisher's Alpha, Q Statistic and Evenness were calculated using Species Diversity and Richness IV software. Comparisons between the type of ecosystems were made with the randomization test of Solow (1993) (Seaby & Henderson, 2006).

Furthermore, the environmental factors (soil pH, N, P, K, plant litter and organic matter; precipitation; air temperature and humidity; altitude and slope) affecting the woody plant species richness and diversity (Shannon–Wiener index) were studied with the help of information systems, using Principal Component Analysis (PCA) with the ordination software CANOCO (Braak & Šmilauer, 2002).

3. RESULTS

3.1. Woody Species Composition and Diversity

Thirty species of plants belonging to 24 genera and 17 families were recorded from the study area. Among these woody plants, 25 species are recorded in abandoned olive groves and 30 in maquis

(Table 1). The more frequently occurring woody species were: *Olea europaea* (19.85%) and *Olea europaea var. sylvestris* (9.01%) in abandoned olive groves, and *Pistacia lentiscus* (8.47%) and *Olea europaea var. sylvestris* (7.94%) in maquis (Figure 4). *Olea europaea var. sylvestris* (Status:Native, Chorology:Mediterranean, Life-form:Phanerophyte) and *Pistacia lentiscus* (Status: Native, Chorology: Mediterranean, Life-form:Phanerophyte) are two of the most important woody plant species of the Xeric Mediterranean phrygana and grasslands, woodlands and maquis having wide distribution in the Greek region (Figures 5 and 6).

Diversity indices (Species richness, Shannon Wiener, Simpsons D, Margalef D, McIntosh D, Brillouin D, Fisher's Alpha, Q Statistic, Evenness) were computed from the number of individuals of each species and they showed that maquis exhibited a significantly greater value of woody plant diversity compared to abandoned olive groves (Table 2).

3.2. Impacts on Environmental Factors on Woody Plant Species Richness and Diversity

According to PCA, the first two PCA ordination axes explain 95% of the data variation, where 80% is displayed on the first axis and 15% is displayed on the second axis (Table 3). According to Figure

Table 1. Woody plant species of the study area

Woody plant species	Family	Abandoned olive groves	Maquis
***Arbutus andrachne* L.**	Ericaceae	-	+
***Arbutus unedo* L.**	Ericaceae	+	+
***Asparagus officinalis* L.**	Asparagaceae	+	+
***Calicotome villosa* (Poir.) Link**	Fabaceae	+	+
***Cercis siliquastrum* L.**	Caesalpiniaceae	+	+
***Cistus creticus* L.**	Cistaceae	+	+
Erica manipuliflora Salisb.	Ericaceae	+	+
***Ficus carica* L.**	Moraceae	+	+
***Fumana thymifolia* (L.) Webb**	Cistaceae	+	+
***Juniperus oxycedrus* L.**	Cupressaceae	+	+
***Juniperus turbinata* Guss.**	Cupressaceae	+	+
***Myrtus communis* L.**	Myrtaceae	+	+
***Olea europaea* L.**	Oleaceae	+	-
Olea europaea* L. subsp. *europaea	Oleaceae	+	+
***Paliurus spina-christi* Mill.**	Rhamnaceae	+	+
***Phlomis* L.**	Lamiaceae	-	+
***Pistacia lentiscus* L.**	Anacardiaceae	+	+
***Pistacia terebinthus* L.**	Anacardiaceae	+	+
***Pyrus spinosa* Forssk.**	Rosaceae	+	+
***Quercus coccifera* L.**	Fagaceae	+	+
***Quercus pubescens* Willd.**	Fagaceae	-	+
***Rhamnus* L.**	Rhamnaceae	+	+
***Rubus hirtus* Waldst. & Kit.**	Rosaceae	+	+
***Salvia officinalis* L.**	Lamiaceae	-	+
***Satureja thymbra* L.**	Lamiaceae	+	+
***Smilax aspera* L.**	Smilacaceae	+	+
***Thymbra capitata* L. Cav.**	Lamiaceae	+	+
***Spartium junceum* L.**	Fabaceae	+	+
***Ulmus glabra* Huds.**	Ulmaceae	-	+
***Vitex agnus-castus* L.**	Verbenaceae	+	+

Figure 4. Frequency of occurrence (%) of woody plants in abandoned olive groves and maquis

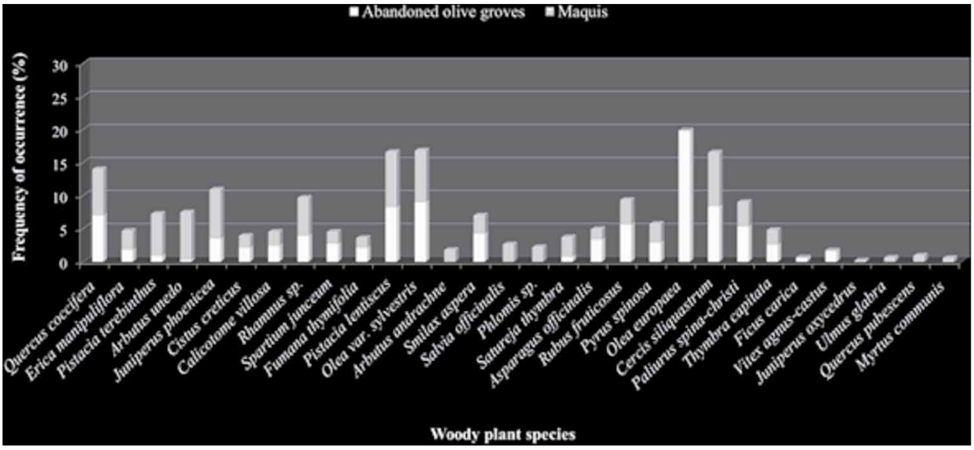


Figure 5. Distribution of *Olea europaea var. sylvestris* **[Geography: IoI (Ionian Islands)–NPi (North Pindos) SPi (Souh Pindos) Pe (Peloponnisos) StE (Sterea Ellas)–EC (East Central Greece) NC (North Central Greece) NE (North-East Greece) NAe (North Aegean islands) WAe (West Aegean islands) Kik (Kiklades) KK (Kriti and Karpathos) EAe (Kriti and Karpathos). Greece: (East Aegean islands – present; East Central Greece – present; Ionian Islands – present; Kiklades – present; Kriti and Karpathos – present; North Aegean islands – present; North Central Greece – present; North Pindos – absent; North-East Greece – present; Peloponnisos – present; South Pindos – present; Sterea Ellas – present; West Aegean islands – present)] (Dimopoulos et al., 2013).**

Figure 6. Distribution of *Pistacia lentiscus* [Geography: IoI (Ionian Islands)–NPi (North Pindos) SPi (Souh Pindos) Pe (Peloponnisos) StE (Sterea Ellas)–EC (East Central Greece) NC (North Central Greece) NE (North-East Greece) NAe (North Aegean islands) WAe (West Aegean islands) Kik (Kiklades) KK (Kriti and Karpathos) EAe (Kriti and Karpathos). Greece: (East Aegean islands – present; East Central Greece – present; Ionian Islands – present; Kiklades – present; Kriti and Karpathos – present; North Aegean islands – present; North Central Greece – absent; North Pindos – present; North-East Greece – present; Peloponnisos – present; South Pindos – present; Sterea Ellas – present; West Aegean islands – present)] (Dimopoulos et al., 2013).

Table 2. Woody plant species diversity indices in abandoned olive groves and maquis

Diversity indices	Abandoned olive groves	Maquis	P
Species richness	25	30	*
Shannon Wiener	2.69	2.98	*
Simpsons D	10.23	16.18	*
Margalef D	3.39	3.96	*
McIntosh D	0.70	0.76	*
Brillouin D	2.64	2.94	*
Fisher's Alpha	4.49	5.24	*
Q Statistic	7.70	8.40	*
Evenness	0.77	0.86	*

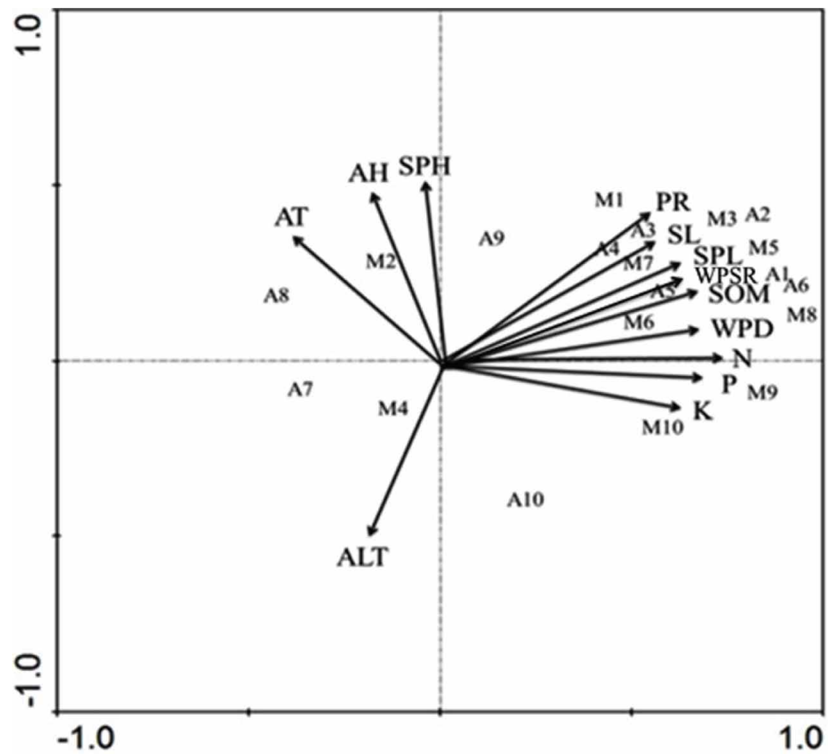
* < 0.05: Statistical differences

7, in maquis woody plant species richness and diversity were positively correlated with soil organic matter and plant litter, N, P, K, slope and precipitation. Also, positive correlations among woody plant species richness and diversity, and soil organic matter and slope were detected in abandoned olive groves.

Table 3. PCA summary of the relationship among woody plant species richness and diversity, and environmental factors

Axes:	1	2	3	4	Total variance
Eigenvalues:	0.80	0.15	0.04	0.08	1
Cumulative percentage variance of data:	80.00	95.00	99.00	99.8	
Sum of all unconstrained eigenvalues:					1

Figure 7. PCA



4. DISCUSSION

Biodiversity is globally used to evaluate ecosystem health because it affects key ecological processes of the ecosystems (Hooper et al., 2005). Two of the most of the main causes of biodiversity loss in agricultural landscapes are the intensification of agricultural practices and land abandonment (Donald et al., 2001; Tscharntke et al., 2005). The effects of land abandonment on biodiversity are complex and depends on (a) the proportion of abandoned ecosystems within a landscape (Sirami et al., 2008), (b) prior land use (Rey Benayas et al., 2007), and (c) the biogeographic origin of the impacted species (Suarez-Seoane et al., 2002).

Woody plant species are a key component of natural ecosystems and responsible for their architecture (Stapanian et al., 1997) and influence the overall composition of the tree communities (Naidu & Kumar, 2016). It is noteworthy that they provide food in the form of leaves, flowers, pollen, nectar, mast and fruit. Woody plants also provide cover, which protects fauna from predators and bad weather conditions. The type and percentage of cover required varies among wildlife species. More specifically, according to literature bird species population, habitat selection and foraging efficiency are influenced by vegetation structural diversity (Rais et al., 2010; Joshi et al., 2012; Gandiwa et al., 2013).

It is vital that floristic composition studies are essential in view of their value in understanding the extent of plant diversity in abandoned and natural ecosystems. The study of floristic composition and structure of abandoned and natural ecosystem reserves is also useful in identifying important elements of floristic diversity, protecting threatened species, and monitoring the status of these ecosystems (Akinyemi & Oke, 2014).

Olea europaea var. sylvestris and *Pistacia lentiscus* are abundant and widespread in the thermomediterranean part of the Mediterranean basin (Wilson, 1993; Solomou & Sfougaris, 2015). According to Dimopoulos et al. (2013), these woody plant species occur naturally in the Xeric Mediterranean phrygana and grasslands, woodlands and maquis. Also, Oliveira et al. (2011) refers that woody plant species such as *Olea europaea var. sylvestris* and *Pistacia lentiscus* have high survival rates over the study period. As far as growth is concerned, these woody plant species also had the highest growth after eight years of study.

Escudero et al. (1999) and Diaz et al. (2007) report that abiotic factors play an important role in the dynamic development of plant species. Abiotic factors must be taken into account for the prediction and evolution of different ecosystems, e.g. of the grassland ecosystems (Volaire, 2008).

Inouye et al. (1987) in Minnesota USA and Sobrino et al. (2002) in south-eastern Spain found that the process of change and replacement of the species is linked to the productivity of the ecosystem. Its evolution vegetation is related to fertility (Teira & Peco, 2003), soil degradation (Bolling & Walker, 2000), the type of disturbances that cause it (Setiawan & Sulistyawati, 2008), as well as the availability of soil water (Otto et al., 2001, 2006). In dry and semi-dry conditions, the availability of water has characterized as one of the most important factors that control it productivity, heterogeneity in the distribution of plants, as well as forms of life (Noy-Meir, 1973). Also, exposure, climate (Teira & Peco, 2003) and time (Mouquet et al., 2003) play an important role in the dynamic evolution of vegetation (Karakosta, 2012).

Greece is one of the richest countries in Europe in terms of floristic diversity. Landscapes are dynamic and change continually under the influence of several driving forces but the rate of change can differ significantly (Sluis et al., 2014).

Foster & Tilman (2000) and Bonet & Pausas (2004) studied the evolution of vegetation over a semi-dry continental and Mediterranean climate, found that the change in the composition of vegetation is most noticeable in the early stages in relation to the advanced ones and gradually decreases with the successive evolution of vegetation.

Csecserits & Redei (2001) also reached similar conclusions, who studied the evolution of the vegetation of abandoned fields in a warm temperate climate in central Hungary, pointed out that the greatest variations in plant species occurred during the first ten years after abandonment. In Egypt, El-Sheikh, (2005) found that the major changes in plant species composition were almost complete within the 25 years after abandonment. Milchunas et al. (1988) report that changes in the flora composition after abandonment are greater in humid environments. However, Castro & Freitas (2009) report that abandonment leads to a change in the structure and composition of the vegetation, since the herbaceous plant species is replaced by the shrubs (Karakosta, 2012).

Our study shows that woody plant species richness and diversity were higher in the maquis than in the abandoned olive groves. These results can be explained by the Ecological Succession Hypothesis through which the abandoned olive groves tend to gradually develop into the natural Mediterranean type vegetation (Vokou, 1988).

In the secondary Succession of vegetation, the influence of the biotic environment is very important. Milton (1995) refers that the plant species richness is determined by the vegetation of the surrounding area. In other studies (Foster & Tilman, 2000, Meiners et al., 2002) the authors stated that the evolution of vegetation depends on the life cycle and the operational characteristics of the species that first arrive, the growth rate and life duration of the plant species (Glenn-Lewin & Van der Maarel, 1992), adaptive installation capacity of the plant species in the different environmental conditions (Papanastasis, 2008), depletion of the seed bank (Bekker et al., 1997) and the competition (Hansson & Hagelfors, 1998, Karakosta, 2012).

It is remarkable that the examination of woody plant species richness as well as its interaction with its geographical variation and the environment at a national level, leads to the interpretation of plant diversity provenance and preservation. It also explains the geographical expansion in general and the multidimensional woody plant diversity in particular at an international level.

According to Cramer et al. (2007), abandoned fields are an opportunity to restore the original natural vegetation. In Latin America (Cramer et al., 2007), the abandonment of land-boundary yields in mountainous areas due to increased population urbanization and intensification of agriculture on fertile lowlands is seen as an opportunity to strengthen ecosystem restoration and biodiversity protection through the rational design of land use policies. Kosmas et al. (2000) report that the abandonment of agricultural land can lead to two diametrically opposite effects: the regeneration of natural vegetation and its complete restoration or its degradation and desertification due to overgrazing.

According to the literature (Song et al., 2010) plant diversity has been shown to have a high degree of spatial variability that is controlled by both abiotic and biotic factors. Our results indicate that, according to PCA, soil organic matter and nutrients are the most dominant factors influencing the woody plant species richness and diversity of abandoned olive groves and natural ecosystems, followed by topography and climate. These results mean that soil organic matter and plant litter provide major nutrients such as magnesium, calcium, potassium, nitrogen, phosphorus, sulfur, and lime, from which plants use large amounts for their growth and survival (Smith 1999–2013).

According to Fraterrigo et al. (2005) and Standish et al. (2006), land use history may have long-term effects on the spatial distribution of soil nutrients, which may have a direct effect on the habitat of the wild vegetation or indirect through their competition with plant species (Riege & del Moral, 2004).

It is highlighted that environmental factors influence the patterns of plant diversity, in turn; vegetation affects soil properties at different scales. More specifically, several environmental parameters such as nutrients, soil humus, rainfall and temperature may have favored the growth of these species in both abandoned olive groves and maquis (Peng et al., 2012; Solomou & Sfougaris, 2015).

Also, topography (e.g. slope) and climate (e.g. precipitation), are widely used to explain the spatial distribution of plant communities (Hamilton, 2010; Lowe et al., 2012). Coblentz and Keating (2008) refer to their study that topographic variability provides a wide range of microclimatic conditions and can support high woody plant diversity and structure. Peng et al. (2012) and, Solomou and Sfougaris (2015) underline that slope has an important role in soil organic matter and available total N, P and K, which are important factors for the woody plant development and diversity.

Moreover, precipitation is critical for plant growth and plays a key role in determining the distribution and diversity of plants. The water availability for plant growth is affected by the amount and type of precipitation, as well as soil characteristics, temperature and wind (National Climate Assessment, 2015).

Finally, Cramer et al. (2007) refers in their study that interactions of crop intensity with soil characteristics and initial natural vegetation determine the dynamic evolution of plant communities in abandoned fields. Also, these interactions determine the degree of effort required to restore the original natural vegetation, which either nearing the original natural stage of vegetation, or remaining in a degraded stage because it is difficult to recover.

5. CONCLUSION

This study detected a high plant species similarity between maquis and abandoned olive groves, indicating that abandoned olive groves follow the rules of ecological succession. Also, the interactions of biotic and abiotic factors can play a decisive role in the succession of the vegetation of abandoned fields. This study is important as it will provide valuable information for ecological process and develop effective management practices for abandoned olive groves and natural ecosystems at different stages. Furthermore, ethnobotanical studies should be conducted to harness the indigenous knowledge on the uses of plant resources contained in the above ecosystems. Also, the use of Geographic Information System (GIS) for a decision support system to assess environmental sustainability could give vital information concerning woody plant species diversity in the future. The data produced is the first in this important ecological area, thus providing baseline information for further research with the help of the information systems.

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APPENDIX

List of Woody Plant Species in the Study Area (Dimopoulos et al., 2013)

Arbutus andrachne L.
Status: Native
Chorology: East Mediterranean
Life-form: Phanerophyte
Habitat: Woodlands and scrub

Arbutus unedo L.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Woodlands and scrub

Asparagus officinalis L.
Status: Native
Chorology: European-SW Asian
Life-form: Chamaephyte
Habitat: Temperate and submediterranean Grasslands, Agricultural and Ruderal habitats

Calicotome villosa (Poir.) Link
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Xeric Mediterranean Phrygana and grasslands.

Cercis siliquastrum L.
Status: Native
Chorology: Mediterranean-SW Asian
Life-form: Phanerophyte
Habitat: Woodlands and scrub

Cistus creticus L.
Status: Native
Chorology: Mediterranean
Life-form: Chamaephyte
Habitat: Xeric Mediterranean Phrygana and grasslands

Erica manipuliflora Salisb.
Status: Native
Chorology: Mediterranean
Life-form: Chamaephyte
Habitat: Xeric Mediterranean Phrygana and grasslands

Ficus carica L.
Status: Native
Chorology: Mediterranean-SW Asian
Life-form: Phanerophyte
Habitat: Cliffs, rocks, walls, ravines, boulders, Woodlands and scrub

Fumana thymifolia (L.) Webb
Status: Native
Chorology: Mediterranean
Life-form: Chamaephyte
Habitat: Xeric Mediterranean Phrygana and grasslands

Juniperus oxycedrus L.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Woodlands and scrub
Juniperus turbinata Guss.
Status: Native
Chorology: Mediterranean-Atlantic
Life-form: Phanerophyte
Habitat: Xeric Mediterranean Phrygana and grasslands, Woodlands and scrub
Myrtus communis L.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Xeric Mediterranean Phrygana and grasslands, Woodlands and scrub
Olea europaea L.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Xeric Mediterranean Phrygana and grasslands, Woodlands and scrub
Olea europaea L. subsp. *europaea*
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Xeric Mediterranean Phrygana and grasslands, Woodlands and scrub
Paliurus spina-christi Mill.
Status: Native
Chorology: European-SW Asian
Life-form: Phanerophyte
Habitat: Temperate and submediterranean Grasslands, Woodlands and scrub
Pistacia lentiscus L.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Xeric Mediterranean Phrygana and grasslands, Woodlands and scrub
Pistacia terebinthus L.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Woodlands and scrub
Pyrus spinosa Forssk.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Xeric Mediterranean Phrygana and grasslands, Woodlands and scrub
Quercus coccifera L.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Woodlands and scrub

Quercus pubescens Willd.
Status: Native
Chorology: Mediterranean-European
Life-form: Phanerophyte
Habitat: Woodlands and scrub

Rhamnus L.
Status: Native
Chorology: East Mediterranean
Life-form: Phanerophyte
Habitat: Cliffs, rocks, walls, ravines, boulders, Woodlands and scrub

Rubus hirtus Waldst. & Kit.
Status: Native
Chorology: European-SW Asian
Life-form: Phanerophyte
Habitat: Woodlands and scrub

Salvia officinalis L.
Status: Native
Chorology: Mediterranean
Life-form: Chamaephyte, Phanerophyte
Habitat: Xeric Mediterranean Phrygana and grasslands

Satureja thymbra L.
Status: Native
Chorology: Mediterranean
Life-form: Chamaephyte
Habitat: Xeric Mediterranean Phrygana and grasslands

Smilax aspera L.
Status: Native
Chorology: Mediterranean
Life-form: Geophyte (Cryptophyte), Phanerophyte
Habitat: Woodlands and scrub

Thymbra capitata L. Cav.
Status: Native
Chorology: Mediterranean
Life-form: Chamaephyte
Habitat: Xeric Mediterranean Phrygana and grasslands

Spartium junceum L.
Status: Native
Chorology: Mediterranean
Life-form: Phanerophyte
Habitat: Agricultural and Ruderal habitats, Woodlands and scrub

Ulmus glabra Huds.
Status: Native
Chorology: European-SW Asian
Life-form: Phanerophyte
Habitat: Woodlands and scrub

Vitex agnus-castus L.
Status: Native
Chorology: Mediterranean-SW Asian
Life-form: Phanerophyte
Habitat: Freshwater habitats, Woodlands and scrub

Alexandra Solomou is a Researcher at the Institute of Mediterranean Forest Ecosystems. She specialized in the management of ecosystems and biodiversity. She has devoted significant work in research related to the management and protection of rural and natural ecosystems, and on biodiversity conservation. Also, her specialties are statistical analysis of biological data and geographic information sciences (GIS). She has many publications and she is a reviewer in several international peer-reviewed journals.

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