

— REVIEW PAPER —

Traditional vs contemporary management of Mediterranean vegetation: the case of the island of Crete

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Received: 31 October 2003

Accepted after revision: 16 January 2004

Mediterranean vegetation is very rich in plant species and vegetation types, highly complex and very vulnerable to human activities. In the past, management practices applied to Mediterranean ecosystems were moderate and resulted in an heterogeneous landscape where vegetation adapted itself and survived through millenia. In the last century though, and especially after World War II, human interventions and modern technology have disrupted the traditional agro-silvo-pastoral equilibrium and resulted in dramatic alterations of the environment including Mediterranean vegetation. Devastating forest wildfires and massive urbanization in coastal areas are only two prominent consequences of these recent developments. Two case studies on the island of Crete, one on the White Mountains where abandonment of the traditional human activities has led to fuel accumulation creating thus a great fire risk, and the other on the mountain Psilorites where intensification of the traditional livestock husbandry has led to land degradation and desertification, suggest that both under- and over- use of the Mediterranean vegetation has resulted in very homogenized and unstable landscapes. The only way to overcome these problems is to create heterogeneous landscapes by proper management of Mediterranean vegetation, so that mosaics are created and the man-nature equilibrium is restored.

Key words: vegetation types, traditional management, contemporary evolution, heterogeneous landscapes, vegetation mosaics.

INTRODUCTION

Mediterranean vegetation is rich in plant species and very variable in architectural, ecological and life forms. Herbaceous and woody species, cryptogams and phanerogams, variably shaped bushes and trees are all closely intermixed to create various kinds of mosaics that characterize the Mediterranean environment and landscapes. This vegetation is the product of a peculiar climate, a variable geology and a heterogeneous and broken relief. All these factors, together with a very rich tectonic history (Grove & Rackham, 2001), resulted in increased plant diversity with numerous endemics and a wealth of vegetation types. According to Le Houerou (1981), the Mediterranean flora consists of 15,000 species, which are three times more than the species found in temperate Europe. A more recent report (Cowl-

ing *et al.*, 1996) however raises the number of vascular plants to 25,000, the highest among the five regions of the world with a Mediterranean-type climate.

Over the long history of mankind in the Mediterranean basin, vegetation has received incessant pressures by humans to open up farm land, to develop pastures, to produce food and fiber, to ensure fuel and construction material. All these pressures resulted in vegetation alternation, destruction or even elimination. In the long run, however, vegetation became adapted to the pressures and changes and survived through an equilibrium which has been developed between man and environment (Arianoutsou, 2001).

Since the last century, and especially after World War II, the dynamic equilibrium between man and his environment has been disrupted due to dramatic socio-economic changes and aggressive human interventions which affected primarily Mediterranean

vegetation. As a result, the inherent natural and cultural regenerate feedbacks have been replaced by accelerating degradation processes which have endangered Mediterranean vegetation and open landscapes (Naveh, 1988).

The objective of this paper was to compare traditional with contemporary methods of Mediterranean vegetation management with special reference to the island of Crete.

MAIN TYPES OF MEDITERRANEAN VEGETATION

Mediterranean vegetation covers about 138 million hectares or 15% of the Mediterranean basin countries (Le Houerou, 1981). In Greece, in particular, it covers 40% of the whole country (Arianoutsou, 1998). It grows on a variety of soil types and on areas with a mean annual rainfall ranging from less than 400 to more than 1000 mm.

There are several types of Mediterranean ecosystems, based on the physiognomy of the dominant plant species (Le Houerou, 1977). The most important ones are the following:

- 1. Phryganic ecosystems.** They are dominated by seasonally dimorphic dwarf shrubs of less than 1 m high. These shrubs are often spiny or aromatic and adapted to the long and dry summer period by replacing the large winter leaves with smaller ones in the summer in order to conserve water (Margaris, 1981). They are two-storied plant communities containing besides woody species also a rich understory with herbaceous vegetation. The most common woody species are *Sarcopoterium spinosum* (L.) Spach, *Phlomis fruticosa* L., *Corydanthus capitatus* (L.) Reichenb. fil., *Euphorbia acanthothamnus* Heldr. & Sart. Ex Boiss. and several *Cistus* species. They grow on the driest areas of the Mediterranean region, especially on its eastern part, as well as on a limited area in the western part.
- 2. Shrub ecosystems.** They are dominated by evergreen sclerophyllous broadleaved shrubs, also known as matorral (Tomaselli, 1977). These shrubs can withstand summer drought with their small leathery leaves which have thick cuticle and sunken stomata (Margaris, 1981). Mediterranean shrublands can be subdivided into two main types, maquis and garrigues. Maquis are shrub communities with tall and dense shrubs grown on relatively deep, mainly siliceous soils (Le Houer-

ou, 1992). Dominant woody species include *Pistacia lentiscus* L., *Olea oleaster* L., *Quercus coccifera* L., *Arbutus unedo* L., *Erica arborea* L., *E. manipuliflora* Salisb. and *Phillyrea latifolia* L. Garrigues are shrub communities with tall but open shrubs grown on relatively poor sites, often on limestone (Le Houerou, 1992). Dominant woody species mainly include *Q. coccifera*, but also *P. latifolia*, and *Juniperus* spp. Herbaceous species are also present, especially in garrigues. Both mentioned types are grown in dry areas, but maquis are mostly found in the true Mediterranean zone, while garrigues in the sub-Mediterranean one.

- 3. Forest ecosystems.** They are dominated by coniferous species such as *Pinus halepensis* Miller, *P. brutia* Ten. and *Cupressus sempervirens* L. They occur in the true Mediterranean zone as well as in the sub-Mediterranean one. They are normally open forests with a herbaceous or, more commonly, a dense shrubby vegetation, mainly consisted of maquis species. In addition, forests are dominated by evergreen or semi-deciduous broadleaved species, such as *Quercus ilex* L., *Q. suber* L., *Q. coccifera*, and *Q. ithaburensis* Decaisne. Most of these forests are normally open managed as silvopastoral systems (e.g. dehesas in Spain).

TRADITIONAL MANAGEMENT OF MEDITERRANEAN VEGETATION

Grazing

Grazing by domestic animals is traditionally the main land use in phryganic ecosystems which serve as winter ranges to small ruminants, especially sheep. Phryganic undershrubs are unpalatable to animals. Therefore, forage is provided by the herbaceous species that grow under or among shrubs. When phryganic species become too dense, forage availability is greatly reduced and shepherds set fires to open them up and favor the palatable herbs. Phrygana are well adapted to recurring wildfires and in a period of 3-5 years they return to the original pre-fire community (Arianoutsou-Faraggitaki, 1984; Papanastasis, 1980).

In Mediterranean shrublands, grazing is also a traditional land use. Garrigues are open plant communities and very important forage sources for domestic animals, especially goats. Maquis, on the contrary, are less productive and provide forage of inferior quality to animals (Talamucci, 1987; Papanasta-

sis, 1987). In both types, when shrubs become too dense or too tall to be reached by animals, they are burned by shepherds to improve forage production. These shrubs are also well adapted to recurring wildfires and re-establish themselves by seeds or stump spouting in a period of 5-10 years (Papanastasis, 1988a; 1988b).

Mediterranean forests are also traditionally grazed by domestic animals, especially sheep and goats, but the forage they provide is a secondary product compared to timber or fuelwood. *Quercus* forests also provide acorns eaten by livestock including swine.

Wood production

In the past, phrygic ecosystems were used as a source of burning fuel, but this practice has been abandoned in the last few decades. Shrublands were used for the production of firewood and charcoal. Particularly in maquis, this production was the main use and several areas were managed to serve this purpose.

Mediterranean forests, especially coniferous ones, were principally managed for firewood and timber production. *Q. suber* forests, in particular, were used for cork production (Morandini, 1977).

Other uses

Periodic extensive farming has been a common practice in all Mediterranean ecosystems, especially phrygic, to hold the soil by building terraces. Honey production was an important activity associated with the numerous flowers of spring plants, especially aromatic plants. Honey was also produced by pines, especially *P. brutia*.

Maquis shrubs were used for ornamental purposes, for the production of fruits or liquors (e.g. *Arbutus unedo* L., *Ceratonia siliqua*, etc.) and for the construction of various tools (e.g. pipes). Also, the cups of the acorns of *Quercus* species, especially *Q. ithaburensis* subsp. *macrolepis*, were used for the extraction of tannins and dyes (Yannakopoulou, 2002). Finally, resin was an important product of the *P. halepensis* forests.

CONTEMPORARY EVOLUTION

In the last 30-50 years, most of the traditional management practices have been either abandoned, due to the migration of rural people to urban centers and

abroad, or intensified due to the use of modern technology including tractors, bulldozers, fertilizers, pesticides, irrigation, genetically improved crops, etc. (Arianoutsou, 2001). In the meantime, urbanization and touristic facilities threaten to destroy most of these valuable Mediterranean ecosystems.

In phrygic areas, the traditional extensive grazing has been restricted in many places or it has been converted to intensive production of animal products with improved breeds of livestock fed with concentrates which are bought with national and, mainly, European subsidies. To satisfy feed demands of the improved stock, the cycle of pastoral fires has been shortened to less than 3-5 years. These wildfires together with overgrazing have resulted in serious land degradation and desertification (Papanastasis, 1977; Margaris & Koutsidou, 1998). In the meantime, grazing and other activities such as firewood collection and honey production have been ceased in most of these ecosystems (Fig. 1a).

Similar developments are experienced in garigues and maquis, too. In these types, extensive grazing has been almost ceased and most of them have become tall and dense, very prone to hot and devastating wildfires. These fires very often spread out and destroy the surrounding lands including crops, forests and residential areas. Also, parts of the maquis ecosystems have been planted to pines or olive orchards. Both reforestations and olive tree plantations have been carried out with bulldozers, which destroyed the surface productive soil and resulted in gully erosion or even landslides. The traditional charcoal production is still practiced in some areas, while other activities have been discontinued (Fig. 1b).

In forests, no harvesting of timber and firewood is practiced anymore and the traditional resin collection in the *P. halepensis* forests has been almost disappeared due to its low market prices caused by the availability of artificial substitutes (Philippou, 1987). Domestic animals are not grazing, too. As a result, these forests, especially the pine ones, have been abandoned and large amounts of fuel have been accumulated making the forests very vulnerable to wildfires. Since most of these forests are found in the urban-wildland interface, they receive high pressures for subdivision and touristic development and those grown around the large cities have been already built up with permanent or weekend houses (Fig. 1c). Most of the forests swept through by wildfires every year are pine forests grown in suburban

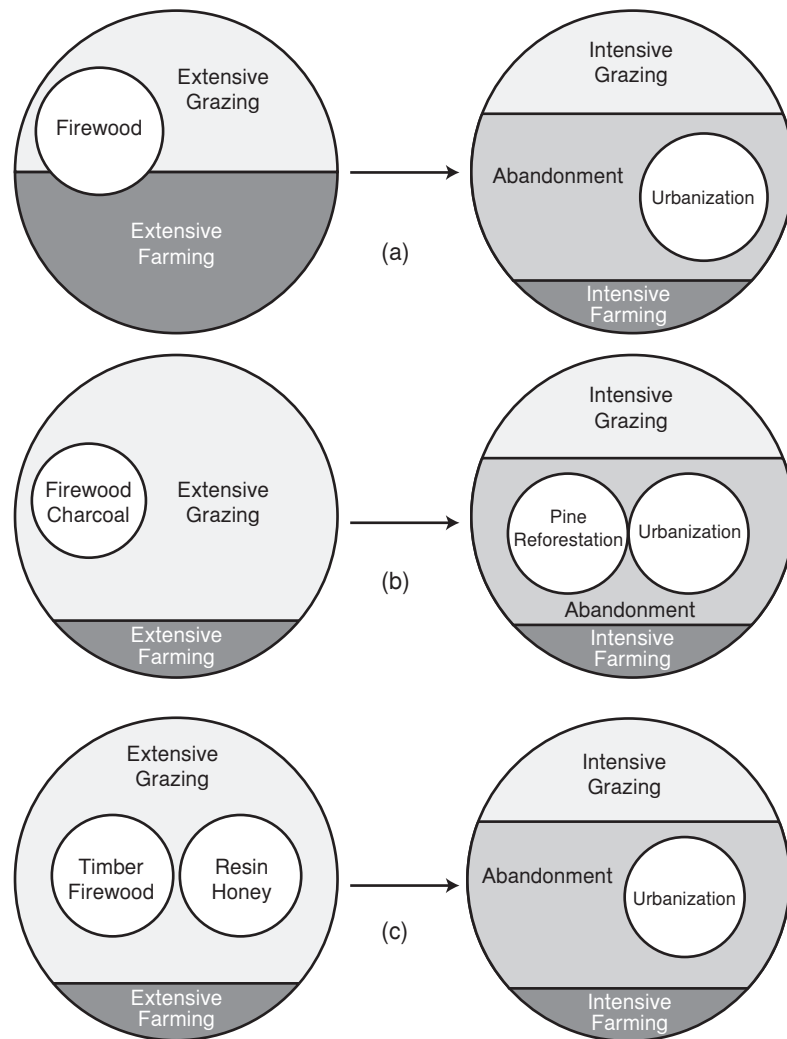


FIG. 1. Trends in land use changes from a traditional agro-pastoral equilibrium (left) to a contemporary agro-industrial stage (right) in phryganic ecosystems (a), maquis and garrigues (b) and coniferous forests (c).

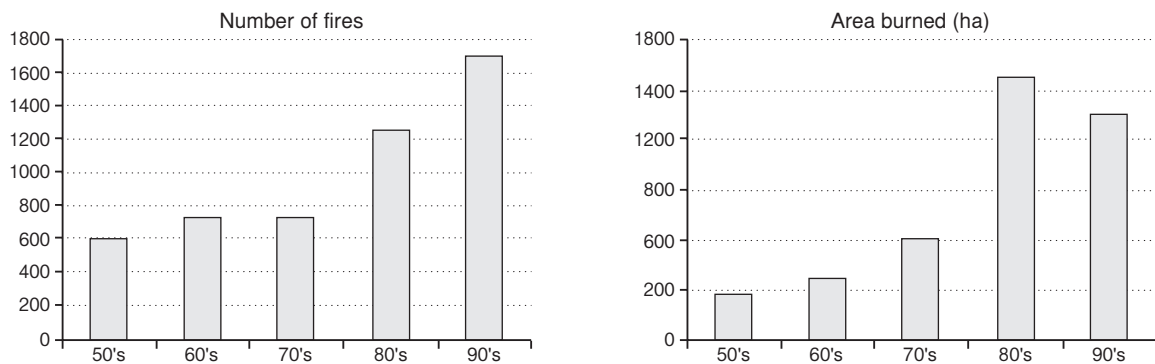


FIG. 2. Evolution of the number of wildfires and the area burned between the 50's and 90's in Greece (Dimitrakopoulos, 2000).

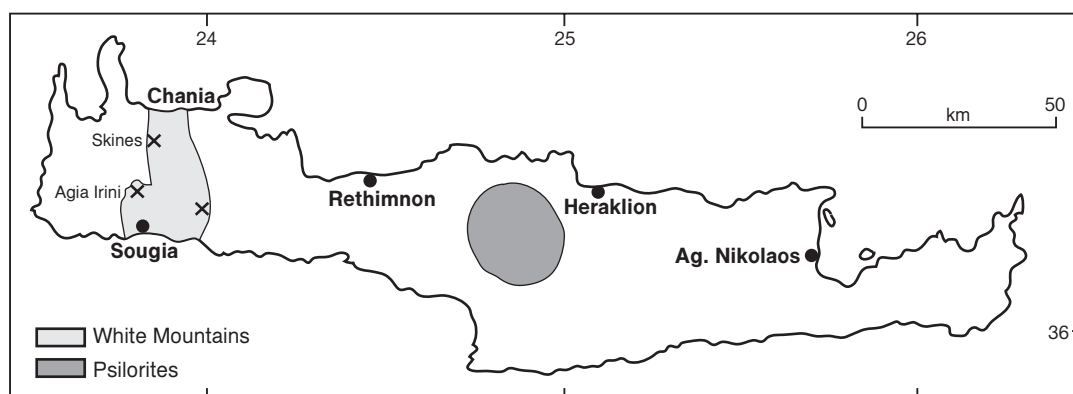


FIG. 3. The studied areas in Crete.

areas.

Because of this contemporary evolution, the number and severity of wildfires have been increased throughout the north Mediterranean countries. In Greece, in particular, the number of wildfires has increased by 3 times and the area burned by 5 times between the 50s and 90s (Fig. 2). Subsequently, the traditional agro-pastoral equilibrium has been converted into an agro-industrial stage (Naveh, 1988).

CASE STUDIES IN CRETE

The impact of the recent management practices on the vegetative cover is manifested in two case studies in Crete. One of them refers to the White Mountains of western Crete and the other to Psilorites Mountain of central Crete. Both are examples of mismanagement of Mediterranean vegetation.

White Mountains

The studied area refers to a strip of land of about 400 km² stretching from the built up north coast western of the city of Chania to the largely underdeveloped south coast to the Libyan sea, near the town of Sougia (Fig. 3). It involves various land cover/use types including the intensively utilized in agriculture Alikianou basin and the protected National Park of Samaria. The whole area was mapped from airphotos taken in 1989 and compared with the land use/cover types in 1945 (Grove *et al.*, 1993). The changes in land use/cover found between these two periods were correlated with the management applied in three representative sites of the whole studied area, namely Skines, Agia Irini and the Samaria National Park (Fig. 3) (Papanastasis & Kazaklis, 1998).

During the 44-year period, it was found that

TABLE 1. Changes of Mediterranean ecosystems in the studied area of Western Crete between 1945 and 1989 (Papanastasis & Kazaklis, 1998)

| Type of ecosystem | Area (ha) | | |
|--------------------|-----------|-------|----------|
| | 1945 | 1989 | % change |
| Phrygana | 7934 | 6544 | -17.5 |
| Garrigues | 6020 | 4832 | -19.7 |
| Maquis | 4222 | 3668 | -13.1 |
| Coniferous forests | 10504 | 12632 | +20.3 |
| Very open (<30%) | 2184 | 1920 | -12.2 |
| Open (30-70%) | 3672 | 2576 | -29.9 |
| Dense (>70%) | 4648 | 8136 | +75.0 |
| Total | 28680 | 27676 | -3.5 |

phrygana were reduced by 18%, garrigues by 19% and maquis by 13%, while the area of forests was increased by 20% (Table 1). These changes were mainly due to the reduction of rural population, which from more than 15 inhabitants/km² in 1951, became reduced to less than 10 in 1991 (Lyrintzis *et al.*, 1998).

These changes, however, were not uniform, neither were caused by the same human activities. In Skines, for example, in a hilly region dominated by maquis the reduction of these ecosystems was mainly caused by their conversion into olive orchards, which altered the environment (Table 2). In Agia Irini, a village maintaining a large number of grazing domestic animals, the dominant garrigues were reduced due to the combination of pastoral wildfires and overgrazing (Table 2). In the Samaria National Park, finally, *P. brutia* forests were increased both in area and density due to the cessation of human activities since 1962 when the region has been established as a park (Table 2).

Overall, the whole studied area of the White

TABLE 2. Changes of vegetation types in selected areas of western Crete between 1945 and 1989 (Papanastasis & Kazaklis, 1998)

| Type of ecosystem | Skines Area (ha) | | | Agia Irini Area (ha) | | | Samaria Gorge Area (ha) | | |
|--------------------|---------------------|------|----------|-------------------------|------|----------|----------------------------|------|----------|
| | 1945 | 1989 | % change | 1945 | 1989 | % change | 1945 | 1989 | % change |
| Phrygana | 76 | 252 | +231.6 | 512 | 536 | +4.7 | 1104 | 752 | -31.9 |
| Garrigues | 556 | 108 | -80.6 | 796 | 720 | -9.6 | 244 | 188 | -22.9 |
| Maquis | 1316 | 1084 | -17.6 | 244 | 252 | +3.3 | 0 | 0 | 0.0 |
| Coniferous forests | 0 | 0 | 0.0 | 96 | 172 | +79.2 | 3420 | 3896 | +13.9 |
| Very open (<30%) | 0 | 0 | 0.0 | 0 | 0 | 0.0 | 688 | 340 | -50.6 |
| Open (30-70%) | 0 | 0 | 0.0 | 36 | 60 | +66.7 | 588 | 492 | -16.3 |
| Dense (>70%) | 0 | 0 | 0.0 | 60 | 112 | +86.7 | 2144 | 3064 | +42.9 |
| Total | 1948 | 1444 | -25.8 | 1648 | 1852 | +12.4 | 4768 | 4834 | +1.4 |

Mountains became homogenized and overwhelmed by an expanding *P. brutia* pine forest creating a great fire hazard.

Psilorites

Psilorites Mountain (Fig. 3), covering an area of about 500 km², is a different case. There, rural people remained but intensified livestock husbandry by increasing the number of sheep and goats by more than 4 times between 60s and 90s (Menjli, 1994). The main reason for this increase was the national and EU subsidies to sheep and goat growers (Lyrintzis *et al.*, 1998). The area is also subjected to periodical wildfires set by shepherds to control the unpalatable phryganic half-shrubs.

As in the White Mountains, the land cover/use types of the mountain were napped from air photos

taken in 1989 and compared with those in 1961 (Table 3). It was found that the changes in the area of the major types was minimal, but sparse shrublands corresponding to phryganic areas were impressively increased at the expense of the dense shrublands, indicating a degradation of the woody vegetative cover (Papanastasis, 1998). In addition, the combination of wildfires and overgrazing in phryganic ecosystems resulted in significant reduction of plant diversity (Papanastasis *et al.*, 2002).

This evolution indicates again a homogenized pattern caused this time not by abandonment of the traditional activities, but by intensifying livestock grazing in combination with pastoral wildfires. Also, this pattern does not create a fire risk, but it leads to the same results as the pattern in White Mountains, namely to land degradation and desertification.

TABLE 3. Land cover/use changes between 1961 and 1989 in Psilorites Mountain of Crete (Bankov, 1998)

| Types of ecosystems | Area (ha) | | |
|---------------------------------|-----------|---------|----------|
| | 1945 | 1989 | % change |
| Artificial surfaces | 245.4 | 245.4 | 0.0 |
| Arable lands | 33.5 | 33.5 | 0.0 |
| Fruit trees | 3547.0 | 3837.0 | -8.2 |
| Annual & permanent crops | 9994.1 | 7763.3 | -22.3 |
| Sparse forests (10-40% density) | 3502.4 | 3212.4 | -8.3 |
| Medium forests (41-70% density) | 2046.8 | 1840.4 | -10.1 |
| Dense forests (71-100% density) | 66.9 | 44.6 | -33.3 |
| Sparse shrubs (10-40% density) | 1589.5 | 2939.1 | +84.9 |
| Medium shrubs (41-70% density) | 13753.1 | 17082.6 | +24.2 |
| Dense shrubs (71-100% density) | 20507.0 | 18231.5 | -11.1 |
| Grasslands | 239.8 | 295.6 | +23.3 |
| Bare rock | 245.4 | 245.4 | 0.0 |
| Total | 55770.9 | 55770.9 | 0.0 |

CONCLUSIONS AND RECOMMENDATIONS

The information presented above clearly indicates that the management practices applied in the Mediterranean ecosystems in the last few decades are creating imbalances in the natural environment which lead to homogeneous landscapes, very prone to disastrous wildfires or to soil erosion and reduction of biodiversity. Distinctive features of such landscapes are: reduced rural population, abandoned terraces, neglected olive groves, expanded flammable vegetation mainly consisted of woody species, undergrazing or overgrazing by livestock and intensively cultivated monocultures. All these features have become prominent in several parts of Mediterranean region indicating the phasing out of the traditional heterogeneous landscapes, which characterize the Mediterranean environment and have ensured a sustainable way of life to people over the centuries.

To overcome the consequences of these developments urgent actions should be taken. The main target in reversing this situation should be the establishment of a heterogeneous landscape that has an increased diversity and stability. The most effective tool to achieve this target is the management of vegetation aiming at disrupting its continuity, creating mosaics and re-instating a man-nature equilibrium. Measures to be taken include re-establishment of human activities in rural areas which are compatible with the environment and improvement of socio-economic conditions so that young people are attracted to stay and live in the countryside. Organic farming and livestock husbandry, agroforestry practices and ecotourism coupled with appropriate economic incentives are some activities that can help revitalizing mountain areas so that Mediterranean vegetation is best managed and maintained.

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