

— REVIEW PAPER —

Environmental conservation in classical Greece

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Natural environment and its conservation in classical Greece (5th to 4th centuries BC) has been a considerably debated issue. Some scholars argue that classical Greece was a land of noble forests and crystal fountains that was relentlessly destroyed by human activities while others denounce this pessimistic view by claiming that humans had a positive impact on the Mediterranean landscape. After reviewing the most relevant literature, it came out that abiotic conditions and biotic resources were not much different from the present ones. Agriculture was based on cultivation of small fields (2-4 ha), involved multiple cultures and crop rotation while production aimed at self-sufficiency and not to yield maximization thus implying sustainable use of arable lands. Livestock husbandry involved small flocks associated with arable agriculture, which indicates a limited impact on the environment. Wildfires were present but not devastating. On the contrary, forests were largely over-exploited and produced mainly firewood than timber while hunting was intensive although practised for social (e.g. prestige) than economic reasons. These practices suggest that people did not destroy their environment in the classical period but rather transformed it to meet their needs. They were not conservation-minded but seem to have known the strengths and weaknesses of their environment. It is this knowledge that probably helped them to also develop an advanced civilization.

Key words: agriculture, climate, forestry, hunting, landscape, livestock husbandry.

INTRODUCTION

Landscapes in the Mediterranean region have been shaped by several abiotic and biotic factors. The former include geology, relief and, especially, climate while the latter include flora and fauna. All these factors interacted and, as they evolved over the geological time, the landscapes evolved as well. This evolution, however, was greatly affected by humans who inhabited the region several thousand years ago and tried to modify the natural landscapes in order to ac-

commodate their needs. According to Willis (1994), the modification started at approximately 4500 BP with the onset of anthropogenic disturbance. In a detailed analysis of the evolution of cultural landscapes in the Mediterranean basin, Naveh & Lieberman (1994) suggest that during the biblical and classical times the densely wooded natural landscape was transformed to a more open and much richer cultural one through agropastoral human activities such as burning, clearing, cutting, coppicing, cultivation and grazing. As a result, the natural vegetation was retained only in the least accessible mountain areas.

Nevertheless, there are two opposing theories as to how the landscape appeared in classical Greece.

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The first one advocates that it was greener and much more forested than today and the current landscape is ruined and degraded compared to the ancient one. This belief originated in the 16th-17th centuries when Renaissance poets and Baroque painters promoted the idea that the great events in classical Greece occurred in a setting not unlike Normandy and central Europe in general (Grove & Rackham, 2001). Later on, in the middle of 18th century, Barthélémy (1788) mentioned by Rackham (1996) visualized classical Greece as a land of noble forests and crystal fountains, like Marie-Antoinette's France, suggesting that Greek environment had been destroyed since classical times. From that time on and especially after the important work of Marsh (1864), the deforestation of the Mediterranean region has been presented as a classical example of man's destructive effects on the environment.

Several scholars tried to scientifically support and popularize this "degradation" or "Lost Eden" theory (e.g. Thirgood, 1981; Hughes, 1983; Tsoumis, 1986; Attenborough, 1987). They claim that human activities (e.g. cultivation, woodcutting, shipbuilding, fire, grazing, etc.) were the main agents of deforestation and landscape degradation. Such degradation has been cumulative up to the present time suggesting that damages done in the classical period were added to those that followed in the Roman, Byzantine, Venetian, Ottoman and subsequent periods. They were largely based on Plato's famous and frequently quoted passage about erosion in Attica in his book *Kritias*, as evidence of mismanagement of natural resources, especially forests (Rackham, 1996). The "degradation" theory was supported by the Clemensian vegetation succession and climax theory of the 20th century (Clements, 1916). Followers of this theory consider Mediterranean ecosystems and especially the sclerophyllous shrubland ecosystems of the region as degraded plant communities and suggest a complete protection from human activities in order to establish forests considered to be the climax vegetation almost everywhere (e.g. Tomaselli, 1977).

The second theory does not accept as real the imaginary past promoted by artists and scientists and denounce the assertion that human action was destructive and resulted in a "ruined landscape". Grove & Rackham (2001), for example, claim that modern Greece has surprisingly changed little since ancient times, except for coasts, deltas and marshes. Also, by comparing ancient authors' records with 19th century travelers and present vegetation, Rackham (1983) ca-

me to the conclusion that Athens area had roughly as much forest in classical times as in the 1920s, and less than it has at present. Moreover, this theory advocates that human interference resulted in the creation of a heterogeneous environment that favored biodiversity by shaping a variety of cultural landscapes (Naveh & Lieberman, 1994; Grove & Rackham, 2001; Blondel, 2006). Blondel & Aronson (1999) argue that human activities have been beneficial for many components of biological diversity because traditional land-use practices act as surrogates of natural disturbance regimes. In such disturbed sites species diversity is much higher than in forest communities (Gomez-Campo, 1985; Perevolotsky & Seligman, 1998; Blondel, 2008).

These opposing theories suggest that there is no agreement among writers and scholars on how the landscape looked like in ancient Greece. However, both of them express extreme views. The former about the "systematic destruction" of the landscape by man denounces all human activities as detrimental while the latter about the "positive impact" of man advocates that all of them were beneficial to the environment. We think that the reality is somewhere between these two extremes. Therefore, instead of adopting any of these two theories, a more meaningful exercise would be to evaluate the human activities in ancient Greece and discuss whether each of them and to what extent were destructive or beneficial to the natural resources. Such a holistic view for the effects of human actions on the environment has not been adequately dealt with for the classical period (5th to 4th centuries BC).

Our objective is to investigate how Greeks of that period, mainly living in Attica, coped with their environment and used natural resources, developing at the same time an advanced civilization. By focusing on the most relevant literature to environmental history, we analyze the abiotic and biotic conditions as well as the human activities and compare them with modern conceptions and practices. We believe that such an investigation will provide important insights to contemporary managers engaged in environmental conservation.

ABIOTIC CONDITIONS

Climate

There is a consensus among scientists that the present-day Mediterranean climate became stabilized around 5000-4500 BP (Late Neolithic to Early Bron-

ze Age) (Bottema, 1994; Willis, 1994; Grove & Rackham, 2001). Since then, the abundant deciduous trees were gradually replaced by evergreen flora (Bottema, 1994; Willis, 1994). This development coincides with the onset of Bronze Age settlements in the Mediterranean region and the increasing influence of the human factor on the environment. As a result, some scholars, especially palynologists and archaeologists (e.g. van Andel *et al.*, 1990; Bottema, 1994; Willis, 1994; Runnels, 1997), suggested that after the stabilization of climate, human activity took over and shaped the Mediterranean landscape. This means that both climatic conditions and human activities have played an important role in shaping the landscape.

According to Sallares (1991), climate of Greece in the 5th to 4th centuries was virtually the same with the present-day climate. On the contrary, Grove & Rackham (2001) argue that it was a little cooler and less arid than nowadays. Nevertheless, it was characterized by mild winters, dry summers and increased precipitation in November and December (Willis, 1994), whereas there was also regional diversity and inter-annual variability as it was traced through its impact on harvest numbers (Garnsey, 1988). Also, snow was more common in inhabited areas than nowadays (Rackham, 1996).

On the other hand, some scholars suggested that climate of the classical period became more arid in the late 4th to early 3rd centuries. Camp (1982), for example, advocated the hypothesis that there was a drought lasting about 40 years in the second half of the 4th century based on the historical fact that many public wells were abandoned at that period for not supplying water and replaced by major waterworks as well as by an increased number of cisterns in private houses. Sallares (1991), however, denounces this hypothesis by arguing that this period was not characterized by continuous drought but by an alternation of wet and dry phases. Such an argument confirms the great interannual variations embedded in the Mediterranean climate, which is also manifested in our times.

Geology and geomorphology

Closely related to climate is the geology and geographical position of Greece. The extensive coastline and major relief factors, such as the crystalline massif of the Cyclades block and the mountains of Pindos and Crete, are responsible for large-scale altitudinal variations in temperature and precipitation. Climate and geology have resulted in the richness and diversi-

ty of present-day flora (Willis, 1994).

With respect to geology and geomorphology of classical Greece, much attention has been drawn on the history of erosion in the last decades. The washing away of soil from slopes to valleys, rivers and coasts has been a subject of controversy among scholars. Similarly, questions arise as to whether the erosion history of the Mediterranean was completed in two major phases (i.e. the Older and Younger Fill) or in many smaller ones, with the latter being quite unambiguous at present (Grove & Rackham, 2001).

On the other hand, the reasons causing erosion in historical times, i.e. whether they were natural or anthropogenic, remain unclear. Grove & Rackham (2001), for example, developed the thesis that the primary determinant of erosion was tectonics rather than human activities. To support this thesis, Rackham (1996) mentions Thermopylae, where a retreat of the sea makes it difficult to understand the exact place of the ancient battle, as a result of tectonics, which changed the relative levels of land and sea. However, this is not accepted by Butzer (2003) who thinks that tectonics is only locally related to historical soil erosion. After carrying out extensive fieldwork, archaeologists and geoarchaeologists have tried to connect periods of erosion with periods of extensive human activity and to point out deforestation, clearing land for farming and other activities as the main causes of the phenomenon. Van Andel *et al.* (1990), for example, after summarizing three case studies of Holocene erosion from northeastern Peloponnese and Thessaly, concluded that soil erosion events were spatially and temporarily related to human interference in the landscape. Similar conclusions were also reached by Runnels (1995, 1997), an archaeologist who worked together with the previous authors in northeastern Peloponnese, stating that land clearing during intensive human settlements resulted in erosion, which in turn forced people to abandon settlements or, at least, reduce their activities. Krahtopoulou (2000), however, could not entirely attribute Holocene alluvium formations to human activities in Pieria, northern Greece.

Given the nature of Mediterranean climate, characterized by frequent episodes of heavy rainfalls, and the rugged topography of Greece, it is more than certain that there was soil erosion associated with human activities in the classical period. However, there is not sufficient information about its extent and intensity.

BIOTIC CONDITIONS

Flora and vegetation

Mediterranean flora is a complex mixture of taxa of different biogeographic origin. At least five biogeographic elements are present: tropical, Holarctic, Irano-Turanian, Saharo-Arabian and indigenous (Quezel, 1995; Blondel & Aronson, 1999). As a result, Mediterranean region is characterized by a high plant species richness, which is incomparable to other regions of the world (Cowling *et al.*, 1996). The main reason for this high richness is not so much the great variety of species but the remarkable number of endemics (Blondel & Aronson, 1999).

Present-day Greece has more than 6000 vascular species, which is a high plant diversity in relation to the size of the country (Dafis, 1997). This is attributed to its geographical location but also to climate and the diversified relief (Kokkoris & Arianoutsou, 2004). Human activity is also involved in this high diversity. According to Papadimitriou *et al.* (2004), the abandonment of traditional human practices in mountain grasslands over the last 30-40 years has led in the reduction of plant species richness. On the other hand, vegetation is also very variable. It includes phrygana, garrigues, maquis, deciduous forests (*Fagus* sp., *Quercus* sp., *Castanea* sp., *Tilia* sp. and *Acer* sp.), warm conifer forests (*Pinus halepensis*, *P. brutia* and *P. pinea*), mountain conifer forests (*Abies* sp., *Pinus nigra* and *Juniperus* sp.), subalpine conifer forests (*Abies alba* and *Picea excelsa*) and evergreen sclerophyllous forests (*Quercus ilex*, *Q. coccifera* and *Phoenix theophrasti*) (Arianoutsou *et al.*, 1997).

The question that arises is whether this high diversity also existed in classical period. The main source of information for the history of vegetation is palynological research carried out in various places during the last decades, although scholars signal limitations and interpretation problems of pollen records, especially in the Mediterranean region (Atherden, 2000; Grove & Rackham, 2001). According to pollen diagrams, the Greek landscape experienced an initial expansion of deciduous *Quercus* forests and *Pistacia* woodlands during the early Holocene, which were then gradually replaced by forests dominated by *Abies*, *Pinus* and *Fagus* until approximately 4500 BP. From that time onwards new tree species, mainly fruit-bearing ones such as *Juglans*, *Castanea*, *Platanus*, *Olea* and others, were increasingly established, giving the landscape its present-day form (Bottema, 1994; Willis, 1994; Gerasimidis & Athanasiadis, 1995). Wil-

lis (1994) further stated that the appearance of the tree species was due to the anthropogenic disturbance which reduced the density of woodland thus allowing their gradual establishment. In addition, the abundance of open ground herbaceous types was also increased. The establishment of trees was done either directly by humans or indirectly by spreading out of small pockets of refugia already existing since the last glacial period (Bottema, 1994).

The last stage of development is connected with the beginning of Bronze Age civilization and, therefore, with the extensive anthropogenic activity. After reviewing four pollen diagrams from southern Greece, Gerasimidis (2005) found that natural vegetation was considerably reduced between 800 BC and 800 AD in order to be converted in agricultural land, mainly for cultivation of olive trees, while pine trees were promoted by humans. On the whole, there was a clear change from a landscape dominated by deciduous trees to one dominated by evergreen flora, which corresponds to the gradual increase of aridity of the Mediterranean climate and, of course, to an increased human presence. According to Rackham (1996) and Grove & Rackham (2001), Greece has not witnessed any major botanical changes since classical times based both on pollen records and also on ancient written sources, suggesting that flora and vegetation did not differ much from the present ones.

Apart from the wild flora, there were several domesticated plants in classical Greece as well. Cultivated plants in the whole Mediterranean basin including Greece, from the Neolithic era onward, included grain crops, fodder species, oil-producing plants, fruit crops, vegetables and a variety of condiments, dyes and tanning agents (Megaloudi, 2005; Blondel, 2006). Among fruit crops, the most important were olive, grape and fig. According to Zohary & Spiegel-Roy (1975), these crops were more likely domesticated in the Near East in the 4th to 3rd millennia BC and emerged as important food items in early Bronze Age. As a result of their domestication, their propagation shifted from sexual to vegetative reproduction of clones, a practice that it is still maintained among farmers in the Mediterranean.

Fauna

Like flora, fauna is also very rich in the Mediterranean basin with a higher number of mammal species in the eastern than in the western part (Blondel & Aronson, 1999). In present-day Greece, there are about

670 and 20000 species and subspecies of vertebrates and invertebrates, respectively, which make it one of the richest countries in relation to its size (Dafis, 1997).

Ancient large mammals included both tropical and boreal elements, but by the end of Pleistocene beginning of Holocene (about 10000 BP) most of these species became extinct due to the combined effect of changing climate and relentless human pressure (Tchernov, 1984). In the meantime, many new species invaded Mediterranean Europe from the Middle East and North Africa or introduced by humans (Blondel & Aronson, 1999). During the classical period, some widely distributed species had not yet reached Greece, e.g. the rabbit, native to the Iberian Peninsula.

Among large mammals, wolves, bears, boars, leopards and foxes are mentioned by ancient writers and sometimes depicted in art (Dalby, 1996; Fox, 1996; Voultziadou & Tatolas, 2005). All these animals were reduced in numbers by the 4th century BC, mostly due to increased human population density and hunting. Lion, in particular, was a common symbol in the Mycenaean world and a widespread royal symbol in the Persian, Macedonian and the Hellenistic kingdoms. Lion bones were found in Tiryns (end of the 2nd millennium BC). In classical times, it was restricted in Macedonia and Thessaly and it probably became extinct two centuries later, not only because of human activity but also because of the lack of extensive grasslands and potential prey in the Mediterranean (Sallares, 1991) as well as increased climatic aridity.

Apart from the wild mammals, there were several domesticated species such as dog, cat, horse, donkey, cattle, buffalo, pig, sheep and goats. According to Sallares (1991), the early stages of animal domestication were characterized by a notable decrease in body size. This was also true for horses, which came from Russia. The small size and the physical weakness of horses probably explain why farmers in antiquity preferred the ox as a work animal for ploughing. In the course of time, biological evolution as well as human-induced selection among the domesticated animals resulted in the development of several breeds with various body sizes and strengths (Sallares, 1991). Examples of such attempts in classical Greece are the improvement of the quality of wool produced by sheep as well as the increase of the body size of horse, particularly after Greeks realized in the Persian Wars of the 5th century that the enemy's cavalry was more powerful and heavily armored than their own (Sallares, 1991).

For other groups of fauna (e.g. invertebrates, fresh water fishes, reptiles, amphibian and birds) there is

no evidence that they were much different in the classical period compared with the present one. For example, in their study on bivalve mollusk exploitation in Greek antiquity, Voultziadou *et al.* (2010) have found that ancient Greeks consumed the same bivalve species as people do nowadays in the coastal areas of the Mediterranean.

HUMAN ACTIVITIES

Agriculture

In the past, scientists generally assumed that ancient agriculture was practised in the same way and with the same plants as in modern times. Recent research, however, has shown that this is not true (Sallares, 1991). Major agricultural products in Greece today, such as rice, sugar beet and cotton, were hardly known in the classical period. Others, like maize, potato and tomato were introduced much later. All well known crops of the period, i.e. vines, olives and wheat, were practically made to fit into the Mediterranean environment only in the first millennium BC. Evidence suggests that even the cultivation of fruit-bearing trees was an innovation of that time. Wheat, in particular, was a secondary crop in Attica until the classical times, in comparison to barley. The latter provided greater yield in small landholdings, while wheat bread was regarded a luxury product (Garnsey, 1988; Sallares, 1991; Dalby, 1996). Wheat subsequently became the main cereal, when new, more productive, types of naked wheat evolved (Sallares, 1991).

In the last few years, our understanding of ancient agricultural practices has also changed drastically. The conventional view of agriculture in the classical period based on extensive monoculture of cereals, biennial fallow and no integration of animal husbandry is being revised (Garnsey, 1988; Sallares, 1991; Halstead, 2000). According to Sallares (1991) the character of ancient farming was mainly determined by the word *autarkeia*, which means self-sufficiency. In other words, farmers and city-states strived for subsistence, not high productivity, as great urban markets were absent. Moreover, cereals were preferred to legumes because the latter needed greater amounts of water than the former. Nevertheless, Sarpaki (1992) argues that legumes played an important role for intensification and extensification of agriculture. Also, the practice of intercropping was common, especially the mixture of cereals and olive trees or cereals and legumes, which increased the productivity of single crops. On the other hand, the average landholding in

classical Attica was small and estimated at 2-4 ha (Garnsey, 1988). This means that, apart from the fact that many farmers practically did not employ animal labor, they had to look for other sources of food supply. Such sources could be provided either by small-scale animal husbandry (which is discussed below) or by the various uses of uncultivated land, as suggested by Forbes (1996).

Two more issues concerning agriculture of the classical period must be mentioned here, which are controversial. The first is the question of existence of a class of free peasant farmers. Although recent field surveys have uncovered many isolated rural sites in the ancient Greek landscape, several scholars are unwilling to ascribe them to independent peasant farmers, and seem to prefer interpreting them as rural estates of a few wealthy landowners (Garnsey, 1988; Forbes, 1995).

The second refers to the long-debated issue of terracing in antiquity. There are scholars that assume their ample existence since prehistoric times (e.g. van Andel *et al.*, 1990; Runnels, 1997). Lohmann (1992) claims that the slopes of villages had been almost completely terraced by the 4th century BC and that these terraces were used for large-scale olive production for the market and thus contradicting the theory of subsistence farming in classical Attica. Others, however, do not recognize any firmly datable ancient example nor they can find written mention of this particular practice (Foxhall, 1996). On the contrary, Price & Nixon (2005) claim that they have found written references to terraces after using text drawn from the full array of ancient Greek linguistic registers. In addition, they suggest that some of the physical remains of old terraces may date back to the Graeco-Roman period. Rackham & Moody (1992) agree that there is a growing body of archaeological evidence for terraces going back to the Bronze Age while Frederick & Krahtopoulou (2000) suggest to be cautious with dating of the still-existing terraces. It can be concluded therefore that terracing must have been a popular way of facilitating cultivation on steep slopes in ancient times, including the classical period of Greece.

Livestock husbandry

Ethnographic surveys and approaches which interpret phenomena of the past on the basis of current perceptions have created a picture of ancient pastoralism quite similar to modern practices, i.e. one involving

independent, self-sufficient herders and movement of flocks between winter and summer pastures. However, recent and more careful research has clarified and revised several aspects of ancient pastoralism.

Firstly, it has been indicated that the classical world generally lacked specialized pastoralists (Hodkinson, 1988; Forbes, 1995). Herding animals as a means of subsistence was only an exception, and written sources often imply that herding was regarded as a lower-status activity usually practised by slaves on behalf of wealthy landowners. On the other hand, keeping few animals as a nutritional resource must have been a quite widespread habit of many small arable-based households, whereas larger flocks remained primarily in the hands of the rich. On the whole, animal husbandry did not play a significant role in ancient economy for the additional reason that animals would have to compete with increased human population density within the small territory of ancient city-states (Sallares, 1991).

Secondly, there is general agreement that sheep and goats were far more popular than cattle because they breed and grow faster and can be fed more easily. Furthermore, sheep and goats are better adapted to the upland terrain of the Greek landscape than cattle (Hodkinson, 1988; Sallares, 1991). Special reference should be made to horse breeding, an activity practised by the wealthy people mainly as a means of manifesting superiority. Besides, it has already been mentioned that horses in classical Greece were smaller in size and weaker than today and their primary purpose was no other than competition in diverse races (Hodkinson, 1988; Sallares, 1991).

Transhumance in antiquity is an issue still argued. Although small-scale movement of flocks is supported by references in written sources (Hodkinson, 1988) and by the uncovering of ancient settlements on high altitudes on the Pindos Mountains (Chang & Tournelotte, 1993), large-scale nomadic movement like the ones practised in more recent times in Greece and elsewhere has been contradicted by some modern scholars (Hodkinson, 1988; Forbes, 1995; Halstead, 2000). The main argument, apart from the paucity of ancient evidence, is that such movement requires strongly developed lowland agriculture, great demand for pastoral products and a politically unified territory, all of which were not available in classical times. Thus, movement of flocks in antiquity probably concerned only short migrations with the goal of finding available pasture.

The last issue concerning animal husbandry is the

degree to which it was integrated with arable farming. All previous statements seem to point towards a close relationship of the two. Hodkinson (1988) has even suggested that animals could be kept in or around cultivated fields throughout the year, grazing fodder or the waste products of agriculture and providing manure for the fields. Similarly, Forbes (1995) emphasizes the availability of uncultivated areas for the grazing of animals, but points out that for a major part of the year animals must have been held on agricultural estates. Sallares (1991), on the other hand, tends to undermine the degree of integration between ancient animal husbandry and agriculture. On the whole, however, there seems to be little doubt that ancient animal husbandry cannot have existed in complete divorce from arable farming, but it should be emphasized that classical Greece presented a diversity of landscapes and socio-political conditions, which could justify many different agro-pastoral practices.

The same conclusion is reached by Valamoti (2001, 2007) for an earlier than classical period, namely late Neolithic to early Bronze Age, when farmers had adopted a number of various options as far as animal husbandry is concerned, ranging from a grazing pattern confined to settlements to grazing away from them depending on the availability of feed resources. Farmers in modern Greece also follow a similar strategy.

Forestry

Pollen diagrams describe a gradual expansion during the Holocene of evergreen woodland, dominated by *Pinus* and *Abies*, in place of deciduous forests and the introduction of new, fruit-bearing tree-types after 2500 BC (Bottema, 1994; Willis, 1994; Gerasimidis & Athanasiadis, 1995). They show that the human factor has played an important role in the evolution of Mediterranean forests in historic times until recently. Human history in general, especially population movement up to the mountains or down to the lowlands, has undoubtedly affected and still affects forests, sometimes causing their reduction, retreat or even destruction. At times, however, forests are left to regenerate, while other actions, such as the protection and sometimes the introduction, and expansion of new forest species, can also be attributed to human interference (Gerasimidis, 2000). Thus, evidence from pollen records cannot support an one-sided role of human factor on forest density.

Forests, along with mountains, meadows and springs, were regarded as habitats of nymphs and of the god-

dess Artemis, as well as the original home of mankind in ancient Greece (Hughes, 1983). Groves of trees were devoted to various gods and were thus protected as sacred. Ancient mythology tells us about the heavy punishment of Erysichthon, son of the king of Thesaly, who cut off wood in the sacred grove of Demetra in order to build a big dining hall in his palace, and was punished by the goddess with unlimited hunger (Hughes, 1983). Apart from religious reasons, however, there is no adequate evidence to suggest that ancient Greeks of the classical period were generally conscious and worried about over cutting of forests or concerned with their protection (Meiggs, 1982).

Deforestation has been a particularly popular but controversial issue in the last decades. Based on the present-day picture of Mediterranean forests and the references in ancient writers (mainly Plato), some scholars tried to support a theory of continuous depletion of forests during the course of human history (Thirgood, 1981; Hughes, 1983; Tsoumis, 1986; Chew, 2001). Clearing land for agriculture, fire, grazing by goats, warfare, and woodcutting were presented as the main factors causing deforestation. Others (e.g. Meiggs, 1982; Grove & Rackham, 2001) disagree with this view by arguing that the special features of the Mediterranean vegetation and climate favor savanna-like rather than dense forests. Also, Rackham (1996) points out that cutting trees does not necessarily mean deforestation because they have the capacity to regrow and come back after some time which people, especially literature writers, do not usually notice. It is certain though that classical Athens was short of timber for serious constructions in periods of great demand. During the Peloponnesian war in the 5th century, Athenians had to import timber from more wooded regions of Greece (Macedonia) and elsewhere (e.g. Sicily) (Meiggs, 1982). For wood, on the contrary, there are ancient accounts that it was brought in the city from the nearby farms but we do not know the quantities that were marketed (Rackham, 1996).

In general, ancient sources reveal nothing equal to massive deforestation. According to Grove & Rackham (2001), landscape descriptions by Pausanias (2nd century AD) with the modern landscape does not reveal great changes in forest density compared with the modern landscape. Moreover, damage of ancient forests should not and cannot be exaggerated for the additional reason that religious restrictions such as reverence for trees dedicated to gods and, mainly,

transportation problems imposed automatic checks on exploitation of timber (Meiggs, 1982). However, the pressure for human use of forests was greater than traditional attitudes of respect and preservation. This is manifested by the diplomatic arrangements with other city-states to secure supplies of timber, conservation measures to control floods and the protection of certain forests as reserves or sacred groves (Hughes, 1983). Therefore, the reality lies somewhere between the massive forest depletion and the lack of any serious forest damage by human activities. This means that high forests producing timber must have been destroyed, especially the ones located near human settlements, but coppice forests, maquis, and phrygana, mainly producing firewood, must have been present and regularly exploited.

Special reference should be made to the role of goat grazing and, generally, pastoralism on deforestation. Ancient Greeks, just like modern people, were perfectly aware of the food habits of goats, which can eat almost everything, but have a special preference for young trees. When left uncontrolled, goats could destroy a vineyard or prevent a young forest from regenerating. Equally, pastoralists are often accused, even in modern times, of causing deforestation with several actions, such as burning of forests in order to create pasture, a practice also recorded by ancient writers (Thirgood, 1981; Meiggs, 1982; Hughes, 1983; Forbes, 2000). It has been argued, however, that herders are part of their environment, quite aware of their role in it (Forbes, 2000). On the other hand, goats were and still are a very useful animal when managed properly because they can control the understory vegetation in Mediterranean forests thus releasing nutrients and water for the benefit of trees and reducing the fire risk (Meiggs, 1982; Papanastasis, 1986).

Fire

Fire has a very long history, dating to the Upper Paleolithic (Grove & Rackham, 2001), and has played a decisive role in post-glacial geological and cultural evolution in the Mediterranean basin (Naveh, 1975). It is nowadays widely accepted that the Mediterranean ecosystem includes many fire-adapted or fire-dependent species, which can be easily reproduced by sprouting or seeding. Among the greater plant beneficiaries are woody shrubs and pine trees (Arianoutsou, 1998; Atherden, 2000; Grove & Rackham, 2001).

In Greece, the first archaeological evidence of fire occurrence dates back to the end of the Middle Stone

age (Higgs *et al.*, 1967). After reviewing the history of burning in Greece, Liacos (1973) considers that fire was used as a tool to open up forests and convert them to grasslands for grazing of livestock since the 2nd millennium BC. This fire tool, known as occupational or pastoral burning, was also practised in the Roman times (Hughes, 1983). Since then, landscape changes in the Mediterranean ecosystems were much influenced by fire (Naveh & Lieberman, 1994; Moreno *et al.*, 1998; Arianoutsou, 2001).

On the other hand, writers of the classical period have not often reported forest fires. Among the few references, there is one by Thucydides who states that fires are ignited through the wind rubbing branches together, as well as reports of fires set by armies for military purposes (Thirgood, 1981; Hughes, 1983).

Hunting

It seems that hunting in ancient Greece was practised as a way of showing bravery and virtues such as *agon* (fight), *techne* (art) and *arete* (virtue), mainly by young and wealthy people. Other factors such as food supply and pest-control were less important, although not excluded (Fox, 1996). Hunting was practised in a variety of landscapes (mountains, forests, hillsides, valleys), depending on the prey. Hunters were on horseback or on foot and they used various weapons as well as dogs which were considered as their most precious companion. Among the most popular games were big animals (boars, bears, foxes, wild goats, deer, leopards etc.), hares and many kinds of birds. Most of these made a fine meal, considering that the catch was not used in religious sacrifices (Dalby, 1996; Fox, 1996).

On the other hand, in many cases hunting along with population density and expansion was responsible for the disappearance of animal species. According to Sallares (1991), wild animals like wolves were relatively rare in classical Greece, a time with high population density, and hunters had difficulties finding hares in Attica. As a result, hunting became less practised overtime. Apparently, this was the reason that Xenophon, a well known fan of the sport, complained about its diminishing popularity.

There were, however, a few cases where hunting was specifically carried out to constrain the expansion of a species. This happened in the island of Astypalaia during the reign of the Macedonian king Antigonos Gonatas, i.e. later than the classical period. A man from Anaphe had introduced a pair of hares on Asty-

palatia but they very soon became a plague and threatened to drive people out of their homes. Delphic Apollo was then consulted and he advised them to introduce intensive hunting (Fox, 1996).

DISCUSSION

This review shows that the abiotic conditions in the classical period were not much different compared to the present-day Greece. Perhaps climate was a little cooler than nowadays but it had the typical seasonal and inter-annual variation of the Mediterranean-type climate. Soil erosion was present no matter if it was caused by natural or human factors. However, given the fact that classical Greeks lacked heavy machinery we can assume that soil erosion caused by human practices was not as grave as in modern Greece (Grove et al., 1993).

Wild flora must have been as rich in the classical period as nowadays while domesticated flora was poorer since several modern crops were absent in antiquity. Fauna must have been also as rich as the present-day Greece with the exception perhaps of wild carnivores such as lion who existed in Macedonia but not in Attica. Naveh (1994) claims that there has been a gradual extinction of several species since antiquity as a consequence of habitat degradation and fragmentation. A different view is expressed by Blondel & Médail (2009), who state that apart from large mammals and some endemic species on Mediterranean islands, the postglacial extinction events due to human intervention are relatively few.

On the other hand, people in classical Greece used natural resources as much as they could and the technical means they had at their disposal allowed them. They were certainly periods of intensive as well as of extensive use mainly dictated by cyclic changes in population growth and climatic factors. Overall, however, overexploitation of agricultural resources was prevented by the following facts: a) the *autarkeia*, the self-sufficiency model of agricultural production that promoted subsistence rather than high productivity in farms, b) the intercropping that allowed a more sustained use of arable land, c) the integration of farming with livestock husbandry that led to the efficient use of agricultural byproducts, d) the terracing of steep arable lands that prevented erosion and e) the limited capacity of the technology that it was used to exploit cropped areas. All these practices imply sustainable use of arable lands if compared with the modern ones, which result in intensive arable crop-

ping. This is because they are based on maximization of production through soil amelioration and mechanization, application of fertilizers, pest and disease control and irrigation (Kosmas et al., 1998).

As far as the grazing resources are concerned, overuse must have been practiced around settlements and homesteads but not away from them. Such a pattern is documented by the following facts: a) livestock husbandry was closely related to arable agriculture suggesting that sheep and goats were kept near the farms, b) flocks were rather small in size and c) there is no convincing evidence of long distance movements such as transhumance, at least in Attica. These facts and, especially, the close association of livestock husbandry with arable agriculture suggest that wild lands away from homesteads were not much pressed by livestock implying that their impact on the environment was limited. Nowadays, overgrazing is still present around settlements but also practiced away from them as animals move over long distances through transhumance (Ispikoudis et al., 2004).

Forests must have received a high pressure thus depriving their capacity to produce timber for construction but they supplied wood for cooking and heating. Given the fact though that the economy during the classical period was open, timber was imported from other areas in order to alleviate the problem of high demand. In the meantime, people learned to substitute the missing timber with the abundant stones in building houses and temples indicating their adaptation to the constraints of the physical environment. The situation is similar in modern Greece, since there still is a high shortage in wood products, mainly timber, which is covered by imports (Voulgaridis, 1999).

The lack of reports for major wildfires in classical Greece may suggest that either forests were non-existent or they were much used and clear and, therefore, not prone to burning. The former case is not supported by the reviewed literature indicating that the latter case should be the real one. Taking into account that fire is part of the Mediterranean climate, though, we can assume that there were wildfires in classical Greece but they did not attract the attention of the great writers apparently because they were not devastating. This assumption leads us to the conclusion that the landscape in classical Greece was quite robust and resilient, at least to wildfires. Nowadays, wildfires are a major environmental problem (Dimi-trakopoulos, 2003), having great ecological and eco-

conomic consequences.

Hunting, finally, was a popular activity, well accepted by ancient Greeks, at least in Athens, because legendary hunters such as Hercules were part of their common heritage. With such a perception, it is unlikely that there was any ecological concern about the hunted species. On the contrary, hunting in modern Greece is also a popular activity but controversial regarding its environmental impact.

It is clear therefore that classical Greece does not fit any of the two theories developed on the human impact on ancient ecosystems and landscapes. It was neither a land of noble forests that was relentlessly destroyed by human action (ruined landscape theory) nor human activities were without any negative impact on the landscape (positive effects theory). As a matter of fact, the advanced civilization of classical Greece could not have developed without profoundly affecting species, community and ecosystems (Blondel, 2006).

Unlike the common belief that the Mediterranean environment is degraded, Butzer (2005) claims that Mediterranean world sustained agricultural productivity over millennia thanks to its ecological and human resilience. Mediterranean ecosystems can withstand heavy human impacts because they can regenerate quickly after degradation. Such a resistance is possible due to positive and negative feedback loops between cultural practices and natural systems (Blondel, 2006). If these loops destabilize as a result of unrestrained growth of human population, energy and material consumption as well as technological power will collapse (Naveh & Lieberman, 1994).

It seems that people in classical Greece had exploited the environment and used its natural resources or even abused some of them such as forests and game species. Overall, however, the practices they employed were not devastating but rather moderate resulting in a heterogeneous landscape (Papanastasis, 2004). They did not exceed the limits of Mediterranean ecosystems to resilience. As a result, these ecosystems did not collapse but were able to self-regenerate and recover. By clearing, burning, terracing, coppicing, grazing, browsing, hunting and constructing, people in the classical period modified their natural environment and established an agro-silvo-pastoral equilibrium which apparently helped them to live in harmony with nature and create cultural artifacts as well as viable human societies.

CONCLUSIONS

Promotion of the conservation ethic of resource use in our modern societies can be greatly assisted by retrospective studies of the environmental practices in the ancient world. Classical Greece constitutes an ideal case study due to the considerable literature available on its environmental history. From this review, the following conclusions can be drawn:

- a) Although there are opposing views, the general consensus of scholars and writers is that abiotic and biotic conditions were not much different in classical period compared to the present-day Greece.
- b) Agricultural practices were relatively mild and sustainable characterized by *autarkeia*, a self-sufficient model of agricultural production.
- c) Livestock husbandry was a minor activity compared to arable agriculture and overgrazing must have been practiced around settlements and not away from them.
- d) Forests received a high pressure for timber and imports had to be done from other city-states to meet the demand, but they were capable of producing firewood.
- e) Wildfires were present but not devastating.
- f) Hunting was popular and practiced for social rather than economic reasons.

In general, the natural environment in classical Greece was transformed but not destroyed. People were not conservation-minded but they seem to have known the strengths and weaknesses of their environment. This knowledge probably helped them to also develop an advanced civilization.

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REFERENCES

- Arianoutsou M, 1998. Aspects of demography in post-fire Mediterranean plant communities of Greece. In: Rundel PW, Montenegro G, Jaksic F, eds. *Landscape Degradation in Mediterranean-Type Ecosystems, Ecological Studies 136*. Springer Verlag, Berlin, Heidelberg: 273-295.
- Arianoutsou M, 2001. Landscape changes in Mediterranean ecosystems of Greece: implications for fire and biodiversity issues. *Journal of Mediterranean Ecology*, 2: 165-178.

- Arianoutsou M, Delipetrou P, Dimopoulos P, Economidou E, Karagiannakidou V, Konstantinidis P, Panagiotidis P, Panitsa M, Tsiourlis G 1997. Habitat types in Greece. In: Dafis S, Papastergiadou E, Georgiou K, Babalonas D, Georgiadis Th, Papageorgiou M, Lazaridou Th, Tsiaousi V, eds. *Directive 92/43/EEC, The Project of Habitats in Greece, Network Natura 2000*. Goulandris Museum of Natural History-Greek Center of Biotopes Ecotypes, Thessaloniki: 402-435.
- Atherden M, 2000. Human impact on the vegetation of southern Greece and problems of palynological interpretation: a case study from Crete. In: Halstead P, Frederick C, eds. *Landscape and Land Use in Postglacial Greece*. Sheffield Academic Press, Sheffield: 62-78.
- Attenborough D, 1987. *The first Eden. The Mediterranean World and Man*. Fontana Collins, London.
- Blondel J, 2006. The “design” of Mediterranean landscapes: A millennial story of humans and ecological systems during the historic period. *Human Ecology*, 34: 713-729.
- Blondel J, 2008. On humans and wildlife in Mediterranean islands. *Journal of Biogeography*, 35: 509-518.
- Blondel J, Aronson J, 1999. *Biology and wildlife of the Mediterranean region*. Oxford University Press, New York.
- Blondel J, Médail F, 2009. Biodiversity and conservation. In: Woodward JC, ed. *The physical geography of the Mediterranean*. Oxford University Press, Oxford: 615-650.
- Bottema S, 1994. The prehistoric environment of Greece: a review of the palynological record. In: Kardulias PN, ed. *Beyond the Site: Regional Studies in the Aegean Area*. University Press of America, Lanham: 45-68.
- Butzer KW, 2003. The nature of Mediterranean Europe: an Ecological History. *Annals of the Association of American Geographers*, 93: 494-498.
- Butzer KW, 2005. Environmental history in the Mediterranean world: cross-disciplinary investigation of cause-and-effect for degradation and soil erosion. *Journal of Archaeological Science*, 32: 1773-1800.
- Camp JM, 1982. Drought and famine in the 4th century B.C. *Hesperia Supplements*, 20: 9-17.
- Chang C, Tourtellotte PA, 1993. Ethnoarchaeological survey of pastoral transhumance sites in the Grevena region, Greece. *Journal of Field Archaeology*, 20: 249-264.
- Chew SC, 2001. World ecological degradation: accumulation, urbanization and deforestation 3000 B.C.-A.D. 2000. AltaMira Press, Lanham.
- Clements FE, 1916. *Plant succession*. Carnegie Institute Washington Publications, 242.
- Cowling RM, Rundel PW, Lamont BB, Arroyo MK, Arianoutsou M, 1996. Plant diversity in Mediterranean climate regions. *Trends in Ecology and Evolution*, 11: 362-366.
- Dafis S, 1997. General characteristics of the Greek space. In: Dafis S, Papastergiadou E, Georgiou K, Babalonas D, Georgiadis Th, Papageorgiou M, Lazaridou Th, Tsiaousi V, eds. *Directive 92/43/EEC, The Project of Habitats in Greece, Network Natura 2000*. Goulandris Museum of Natural History-Greek Center of Biotopes Ecotypes, Thessaloniki: 3-9.
- Dalby A, 1996. *Siren Feasts. A History of Food and Gastronomy in Greece*. Routledge, London.
- Dimitrakopoulos AP, 2003. Analysis of forest fire causes in Greece during the period 1956-1997. *Dassiki Erevna*, 16: 17-28.
- Forbes H, 1995. The identification of pastoralist sites within the context of estate-based agriculture in ancient Greece: beyond the ‘Transhumance versus Agro-Pastoralism’ debate. *Papers of the British School at Athens*, 90: 325-338.
- Forbes H, 1996. The uses of the uncultivated landscape in modern Greece: a pointer to the value of the wilderness in antiquity? In: Shipley G, Salmon J, eds. *Human Landscapes in Classical Antiquity. Environment and Culture*. Routledge, London, New York: 68-97.
- Forbes H, 2000. Landscape exploitation via pastoralism: examining the ‘Landscape Degradation’ versus Sustainable Economy debate in the post-medieval southern Argolid. In: Halstead P, Frederick C, eds. *Landscape and Land Use in Postglacial Greece*. Sheffield Academic Press, Sheffield: 95-109.
- Fox RL, 1996. Ancient hunting: from Homer to Polybios. In: Shipley G, Salmon J, eds. *Human Landscapes in Classical Antiquity. Environment and Culture*. Routledge, London, New York: 119-153.
- Foxhall L, 1996. Feeling the earth move: cultivation techniques on steep slopes in classical antiquity. In: Shipley G, Salmon J, eds. *Human Landscapes in Classical Antiquity. Environment and Culture*. Routledge, London, New York: 44-67.
- Frederick CD, Krahtopoulou A, 2000. Deconstructing agricultural terraces: examining the influence of construction method on stratigraphy, dating and archaeological visibility. In: Halstead P, Frederick C, eds. *Landscape and Land Use in Postglacial Greece*. Sheffield Academic Press, Sheffield: 79-94.
- Garnsey P, 1988. *Famine and Food Supply in the Graeco-Roman World*. Cambridge University Press, Cambridge.
- Gerasimidis A, 2000. Palynological evidence for human influence on the vegetation of mountain regions in northern Greece: the case of Lailias, Serres. In: Halstead P, Frederick C, eds. *Landscape and Land Use in Postglacial Greece*. Sheffield Academic Press, Sheffield: 28-37.

- Gerasimidis A, 2005. Deciduous oak forest vegetation history in Greece with emphasis on the effects of human impact as reflected by pollen diagrams. *Botanika Chronika*, 18: 117-133.
- Gerasimidis A, Athanasiadis N, 1995. Woodland history of northern Greece from the mid Holocene to recent time-based on evidence from peat pollen profiles. *Vegetation History and Archaeobotany*, 4: 109-116.
- Gomez-Campo C, 1985. *Plant conservation in the Mediterranean area*. Dr. W. Junk Publishers, Dordrecht.
- Grove AT, Rackham O, 2001. *The Nature of Mediterranean Europe. An Ecological History*. Yale University Press, New Haven.
- Grove AT, Ispikoudis I, Karteris M, Kazakis A, Moody JA, Papanastasis V, Rackham O, 1993. *Green book: Threatened Mediterranean landscapes of western Crete (Adaptation and translation into Greek by V.P. Papanastasis)*. Mediterranean Agronomic Institute of Chania, Chania.
- Halstead P, 2000. Land use in postglacial Greece: cultural causes and environmental effects. In: Halstead P, Frederick C, eds. *Landscape and Land Use in Postglacial Greece*. Sheffield Academic Press, Sheffield: 110-128.
- Higgs EJ, Vita-Finzi C, Harris DR, Fagg AE, 1967. The climate, environment and industries of Stone Age Greece, Part III. *Proceedings of the prehistoric Society*, 33: 1-29.
- Hodkinson S, 1988. Animal husbandry in the Greek polis. In: Whittaker CR, ed. *Pastoral Economies in Classical Antiquity*. Cambridge Philological Society, Cambridge: 35-74.
- Hughes JD, 1983. How the ancients viewed deforestation. *Journal of Field Archaeology*, 10: 435-445.
- Ispikoudis I, Sioliou MK, Papanastasis VP, 2004. Transhumance in Greece: Past, present, and future prospects. In: Bunce RGH, Perez-Soba M, Jongman RHG, Gomez Sal A, Herzog F, Austad I, eds. *Transhumance and Biodiversity in European Mountains. Report of the EU-FP5 project TRANSHUMOUNT (EVK2-CT-2002-80017)*. IALE publication series nr 1: 211-229.
- Kokkoris Y, Arianoutsou M, 2004. Demographic monitoring of four endemic plant taxa in the fire prone-environments of Central Greece: early results. In: Arianoutsou M, Papanastasis VP, eds. *Ecology, Conservation and Management of Mediterranean Climate Ecosystems. Proceedings of the 10th MEDECOS Conference, April 25- May 1, 2004, Rhodes, Greece*. Millpress, Rotterdam. Electronic Edition (<http://www.iospress.nl/loadtop/load.php?isbn=millpress>).
- Kosmas CS, Danalatos NE, Mizara M, 1998. Greece. In: Conacher AJ, Sala M, eds. *Land Degradation in Mediterranean Environments of the World. Nature and Extent, Causes and Solutions*. John Wiley & Sons, New York: 67-77.
- Krahtopoulou, A, 2000. Holocene alluvial history of northern Pieria, Macedonia, Greece. In: Halstead P, Frederick C, eds. *Landscape and Land Use in Postglacial Greece*. Sheffield Academic Press, Sheffield: 15-27.
- Liacos LG, 1973. Present studies and history of burning in Greece. *Proceedings of the 13th Annual Tall Timbers Conference, Tallahassee, Florida*: 237-277.
- Lohmann H, 1992. Agriculture and ancient life in classical Attica. In: Wells B, ed. *Agriculture in Ancient Greece, Proceedings of the 7th International Symposium of the Swedish Institute of Athens*. Skrifter Utgivna an Svenska Institutet i Athen, Stockholm: 29-57.
- Marsh GP, 1864. *Man and Nature, or Physical Geography as Modified by Human Action*. Scriber, New York.
- Megaloudi F, 2005. Wild and cultivated vegetables, herbs and spices in Greek antiquity (900 B.C. to 400 B.C.). *Environmental Archaeology*, 10: 73-82.
- Meiggs R, 1982. *Trees and Timber in the Ancient Mediterranean World*. Clarendon Press, Oxford.
- Moreno JM, Vázquez A, Vélez R, 1998. Recent History of Forest Fires in Spain. In: Moreno JM, ed. *Large Forest Fires*. Backhuys Publishers, Leiden: 159-185.
- Naveh Z, 1975. The evolutionary significance of fire in the Mediterranean region. *Vegetatio*, 29: 199-208.
- Naveh Z, 1994. From biodiversity to ecodiversity: A landscape-ecology approach to conservation and restoration. *Restoration Ecology*, 2: 180-189.
- Naveh Z, Lieberman AS, 1994. *Landscape Ecology. Theory and Application. 2nd edition*. Springer Verlag, New York.
- Papadimitriou M, Tsougrakis Y, Ispikoudis I, Papanastasis VP, 2004. Plant functional types in relation to land use changes in a semi-arid Mediterranean environment. In: Arianoutsou M, Papanastasis VP, eds. *Ecology, Conservation and Management of Mediterranean Climate Ecosystems. Proceedings of the 10th MEDECOS Conference, April 25-May 1, 2004, Rhodes, Greece*. Millpress, Rotterdam, Electronic Edition. (<http://www.iospress.nl/loadtop/load.php?isbn=millpress>).
- Papanastasis VP, 1986. Integrating goats into Mediterranean forests. *Unasylva*, 154: 44-52.
- Papanastasis VP, 2004. Traditional vs contemporary management of Mediterranean vegetation: the case of the island of Crete. *Journal of Biological Research-Thessaloniki*, 1: 39-46.
- Perevolotsky A, Seligman NG, 1998. Role of grazing in Mediterranean rangeland ecosystems-Inversion of a paradigm. *BioScience*, 48: 1007-1017.
- Price S, Nixon L, 2005. Ancient Greek agricultural terraces: Evidence from texts and archaeological survey. *American Journal of Archaeology*, 109: 665-694.
- Quezel P, 1995. La flore du basin méditerranéen: origine, mise en place, endémisme. *Ecologia Mediterranea*, XXI: 19-39.

- Rackham O, 1983. Observations on the historical ecology of Boeotia. *Papers of the British School at Athens*, 78: 291-351.
- Rackham O, 1996. Ecology and pseudo-ecology: the example of ancient Greece. In: Shipley G, Salmon J, eds. *Human Landscapes in Classical Antiquity. Environment and Culture*. Routledge, London-New York: 16-43.
- Rackham O, Moody JA, 1992. Terraces. In: Wells B, ed. *Agriculture in Ancient Greece*, Proceedings of the Seventh International Symposium, Stockholm: 123-133.
- Runnels CN, 1995. Environmental degradation in ancient Greece. *Scientific American*, 272: 96-99.
- Runnels CN, 1997. Umweltzerstörung im griechischen Altertum. In: Hoepfner W, ed. *Frühe Stadtkulturen*. Spektrum, Heidelberg: 136-140.
- Sallares R, 1991. *The Ecology of the Ancient Greek World*. Duckworth, London.
- Sarpaki A, 1992. The palaeoethnological approach: the Mediterranean triad or is it a quartet? In: Wells B, ed. *Agriculture in Ancient Greece. Proceedings of the 7th International Symposium of the Swedish Institute of Athens*. Skrifter Utgivna an Svenska Institutet i Athen, Stockholm: 61-75.
- Tchernov E, 1984. Faunal turnover and extinction rate in the Levant. In: Martin PS, Klein RG, eds. *Quaternary Extinctions*. University of Arizona Press, Tucson: 528-552.
- Thirgood JV, 1981. *Man and the Mediterranean Forest. A History of Resource Depletion*. Academic Press, New York.
- Tomaselli R, 1977. *Degradation of the Mediterranean maquis. Mediterranean Forests and Maquis: Ecology, Conservation and Management*. UNESCO, Paris: 33-72.
- Tsoumis G, 1986. The depletion of forests in the Mediterranean region. A historical review from ancient times to the present. *Scientific Annals of the Department of Forestry and Natural Environment, Aristotelian University of Thessaloniki*, 28: 282-300.
- Valamoti SM, 2001. Archaeobotanical investigation of late Neolithic to early Bronze Age agriculture and plant exploitation in northern Greece. Ph. D. Thesis, University of Sheffield, UK.
- Valamoti SM, 2007. Detecting seasonal movement from animal dung: an investigation in Neolithic northern Greece. *Antiquity*, 81: 1053-1064.
- van Andel TH, Zangger E, Demitrac A, 1990. Land use and soil erosion in prehistoric and historical Greece. *Journal of Field Archaeology*, 17: 379-396.
- Voulgaridis E, 1999. Country report (Greece), Chapter 2.6: Forest production. In: Pelkonen P, Pitkanen P, Schmidt P, Desten G, Pinssi, P, Rojas E, eds. *Forestry in Changing Societies in Europe-Information for Teaching Modul, Part II*. University Press, University of Joensuu, Finland: 144-147.
- Voultsiadou E, Tatolas A, 2005. The fauna of Greece and adjacent areas in the Age of Homer: evidence from the first written documents of Greek literature. *Journal of Biogeography*, 32: 1875-1882.
- Voultsiadou E, Koutsoubas D, Achparaki M, 2010. Bivalve mollusc exploitation in Mediterranean coastal communities: an historical approach. *Journal of Biological Research-Thessaloniki*, 13: 35-45.
- Willis KJ, 1994. The vegetational history of the Balkans. *Quaternary Science Reviews*, 13: 769-788.
- Zohary D, Spiegel-Roy P, 1975. Beginnings of fruit growing in the old world. *Science*, 187: 319-327.