

THE CONTRIBUTION OF VALONIA OAK SILVOPASTORAL SYSTEMS IN WESTERN GREECE TO LOCAL DEVELOPMENT AND THE ENVIRONMENT

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ABSTRACT

This paper presents a synopsis of an investigation on the contribution of valonia oak silvopastoral systems to the local economy and environment in W. Greece. The area is not developed economically and most people are mainly occupied in agriculture and/or husbandry. Valonia oak regeneration is affected by livestock grazing and tree canopy cover. Very low regeneration was observed in various distances from the sheep and goat sheds where livestock were grazing in the surrounding area. On the other hand tree regeneration is strongly related to tree canopy cover, whereas new seedlings were observed under trees due to the favorable micro-environmental conditions. The piospheric approach in the analysis of floristic diversity data revealed that the effect of locations of maximum soil disturbances due to grazing is detrimental in the spatial arrangement of floristic diversity in the valonia oak silvopastoral forests. Irrespectively of the type of index used to quantify α -diversity the negative effect of grazing is reflected in the areas found in the periphery of corrals, where denudation is the rule. Concerning the nutritive value of the valonia oak, its acorns can be considered as a good supplementary feed for the winter period. Specifically, climatic conditions, and subsequently geographical origin, seem to affect crude protein content of acorns. However, it had no effect on Neutral Detergent Fiber, Acid Detergent Fiber and Acid Detergent Lignin contents. Overall, crude protein content of acorns is insufficient to meet maintenance demand of ruminants. Local people take advantage, to a higher or lower extend, of the rich flora of these forests. More than 40 plant taxa used for various purposes, such as medicinal or aromatic, as edible or for other uses such as *Alkanna tinctoria*, whose roots, apart from its medicinal properties, have dyeing properties. During the past decades there is a growing apostrophe on these traditional uses, mainly by young people, preferring other occupational fields or moving to larger urban centers, mainly Athens. On the contrary, children of ages 7-17 appreciated and valued the system. The history of tree-ring growth showed that these old-aged trees were exposed to various human activities and environmental influences. Through the application of allometric equations on the diameter distributions recorded in forest management plans, it can be concluded that valonia oak contributes significantly to carbon sequestration. Interestingly, even if local inhabitants place value to the systems, they are converting them to olive groves and/or agricultural fields.

Keywords: oak, agroforestry, livestock, regeneration, plants

1. Introduction

Silvopastoral systems are rich and viable with great ecological, economic and environmental importance. A sound management must emphasize the outstanding role of silvopastoral systems taking into account their great economic and ecological value. Valonia (*Q. ithaburensis* subs. *macrolepis*) is a characteristic endemic oak species of the Eastern Mediterranean

countries, forming traditional silvopastoral ecosystems in Greece, which were of great value in the past (Pantera *et al.*, 2008). The understory of such silvopastoral systems is composed mainly of holm oak, almonds, olives, carobs, mulberries, several bushes or dwarf shrubs, providing fodder for sheep, goats, and hogs (Pantera *et al.*, 2008). Valonia oak was used in the past for its wood, acorns as well as for tannery (Grispos, 1936; Cristodoulopoulos, 1937; Tsitsas, 1978). A major part of the economy of western Greece, and mainly the region of Aetoloakarnania, during the 17th to 19th centuries, was based on acorn trade and commerce (Giannakopoulou, 2002). During the 20th century, human activities have confined valonia oak to small-forested clusters or isolated individual trees in many areas of continental and insular Greece. The use of low cost, chemical dyes has eliminated the most important use of its acorns in tannery and confined it to their nutritive value. Compared to the past, the system is used for grazing, especially by sheep (Pantera and Papanastasis, 2003). Nowadays farmers are switching valonia oak silvopastoral systems to olive groves and/or agricultural fields.

However, there is a growing interest for these ecosystems in the past few years due to environmental awareness and increased demand for traditional products. Additionally, there has been a growing interest for the species to be included in reforestation as well as research projects (Fotelli *et al.*, 2000; Tsakalimi *et al.*, 2000). Black truffles have been discovered recently in valonia oak forests providing an additional valuable reason for the preservation of these systems (Pantera and Chrisopoulos, 2009). Special incentives must be given to farmers, possibly through subsidies, in order to keep the existing form of their farms and even establish new silvopastoral systems. A great effort is on the way for public awareness, on several of these systems, stressing out that these systems are not only a part of the local economy and environment but also a part of Greek history and tradition.

This article represents an attempt to advance in the quantification and qualification of the contribution of valonia oak silvopastoral systems on local development and the environment in general, in a typical for the species distribution area in W. Greece. The area of interest is not developed economically and the locals are mainly occupied in agriculture and/or livestock husbandry. In the area there is the last biggest dense valonia oak forest in the Balkans however, it is steadily being converted to agricultural fields. The overall purpose of this research attempt is the protection of the traditional silvopastoral systems formed by valonia oak by strengthening their economical and environmental role. Additionally it highlights the economic potentials derived by the reuse or alternative use of these systems.

2. The economic contribution

The canopy of valonia oak forests is open (a feature attributed to human interventions and to the fact that the dominant species is light-demanding), resulting in the occurrence of numerous plant species in the understorey. A lot of these species have particular aromatic, medicinal and livestock-breeding value (Polunin, 1980; Bauman, 1995). In addition, many of these species are used for ornamental purposes (Bauman, 1995), while others may be used as detergents or for energy production. The use of the commonest plant species is described in many commercial books (Mabey, 1999; Ody, 1993), however, in some cases information is false. For example, the common thyme (*Thymus vulgaris*) is mentioned in almost all such books, but it does not exist in Greece, where more than 30 different *Thymus* species occur (Greuter *et al.*, 1984-1989). In western Greece, extensive valonia oak silvopastoral systems are located in plains, a fact that makes their exploitation for the production of specific goods more intensive. As a result, the need for alternative uses of native (wild) species becomes more imperative. Knowledge of local people on the use of native flora, which has stemmed from tradition over centuries (Ali-Shtayeh *et al.*, 2007; Lentini and Venza, 2007; Bauman, 1995), has already been lost in many areas due to urbanization (of people living in rural areas). Such knowledge has to be documented before vanishing because it may include important information on curing diseases, proper nutrition etc. At the same time, there are plenty of species which are not traditionally used, but could become utilizable based on knowledge coming from other regions of Greece (Alibertis, 2006). Based on a recent research (Pantera *et al.* 2014) local people take advantage, to a higher or lower extent, of the rich flora of the valonia oak forests. More than 40 plant taxa

used for various purposes, such as medicinal or aromatic (e.g. *Teucrium capitatum*, *Origanum vulgare*), as edible (*Tragopogon porrifolius*, *Sonchus* spp.) or for other properties, such as *Alkanna tinctoria*, whose roots, apart from its medicinal properties, have dyeing properties (gives red color).

In general, browse trees and shrubs could be considered as a feed supplement in areas with a long dry period with harsh environmental conditions (e.g. Mediterranean regions), because they provide forage for grazing ruminants throughout the year (i.e. evergreen species) or at specific critical periods of the year (i.e. deciduous species), particularly after herbage senescence when the quantity and quality of herbaceous species is limited (Cook, 1972; Devendra, 1990). Grazing studies in Mediterranean shrublands indicated that browse can contribute more than 60% of goat diet, and it can be an integral component of sheep diets (Perevolotsky *et al.*, 1998). However, overgrazing may cause severe injuries (Qaro, 1986; Etienne, 1996) or death of the trees (Rapey, 1994; Etienne, 1996). Grazing has been mentioned as the cause for low natural regeneration in forested areas (Spanos, 1997) as seedlings and acorns may be a major part of the grazing animal diet. Furthermore, grazing directly affects vegetation composition according to the consumption of palatable forage material to animals (Etienne, 1996). The result of food selectivity is the dominance or the disappearance of certain plant species and the consequent change in vegetation composition. Grazing animals firstly consume palatable species and in certain cases, they even consume unpalatable species (Papanastasis and Noitsakis, 1992). Annual grasses may be dominant under the trees crowns in severely disturbed ecosystems (Joffre *et al.*, 1988, Etienne 1996). If applied under a management plan, grazing may influence positively the ecosystems balance. It may positively influence tree growth by removing sprouts (Leouffre, 1991; Etienne, 1996) and, generally, the competitive vegetation in orchards (Sibbald, 1996), or by lowering water stress during the dry period of the year (Carlson *et al.*, 1994 in Etienne, 1996). Furthermore, controlled grazing may influence positively natural regeneration in conifer forests, create and sustain fire breaks (Talamucci *et al.*, 1995). However, grazing has been blamed for soil compaction. Based on Kozłowski (1999), soil compaction represents a major economical and ecological problem. Specifically, there is a variety of reasons that cause soil compaction such as the use of heavy machinery, human and animal trespass. Some of the negative results from soil compaction are soil bulk density destruction, soil air and water decreased or even ceased movement, soil erosion, plant nutrition deterioration, negative effect on soil microorganisms (Kozłowski, 1999; Williamson and Neilsen, 2000; Frey *et al.*, 2009). The major part of the existing literature refers to herbaceous crop species and relatively low information for woody species whereas even fewer are the existing information that includes management and biodiversity (Kirby, 2007).

Although valonia oak acorns are used as animal feed, never so far their nutritive value has been investigated. There is only few recent literature on this subject and refers to acorns of other oak species (Elston and Hewitt, 2010; Owais and Abdelrahman, 2010) or to their protein (Tamer, 2006) and nutrient content (Özcan and Bayçu, 2005). Acorns contain a variety of chemical substances contributing to their economical and nutritive value. Dry and liquid extract are produced by acorns used for tannery commercially known as valex and velonitan. The distinctive yellowish colour of leather goods is attributed to acorns tannins. Based on Bainbridge (1985a), chemical content of certain oak species acorns ranged as follows: 1. Water: 8.7–44.6 %, 2. Tannin: 0.1–8.8 %, 3. Protein: 2.3–8.6%, 4. Energy (kcal/100g): 265–577, 5. Fat: 1.1–31.3 %, and 6. Carbohydrates: 32.7–89.7%. Wolf (1945) and Wagnon (1946), mention that the chemical composition of 8 American oak acorns is in comparable amounts to those of corn (*Zea mays*). Acorns also contain a significant amount of micronutrients justifying their wide use even in human nutrition in several civilizations (Bainbridge 1986a) until recent years (Ofcarcik *et al.*, 1971; Wolfert, 1973; Kavasch, 1979; Bainbridge 1985a, 1986b). Valonia oak acorns could be considered as a good supplementary feed for the winter period (Parissi *et al.*, 2014). Specifically, climatic conditions, and subsequently geographical origin, seem to affect crude protein content of acorns. However, they had no effect on Neutral Detergent Fiber (NDF), Acid Detergent Fiber (ADF) and Acid Detergent Lignin (ADL) contents. Overall, crude protein content of acorns is insufficient to meet alone maintenance demands of the ruminants. A

reevaluation of acorn uses that would include their nutritive value will positively contribute to the protection and the enhancement of valonia oak silvopastoral systems.

3. Social aspects of valonia oak silvopastoral systems

A sustainable local development and sound exploitation of a natural resource must take into account the population group that is actually dwelling within and taking advantage of it. For this it is of great importance to determine the relationship between the forest ecosystem, the agroforestry systems practiced within It and the local population. During the past decades there is a growing apostrophe on these traditional uses, mainly by young people, preferring other occupational fields or moving to larger urban centers, mainly Athens. The economic contribution of valonia oak silvopastoral systems on the local population was assessed in a recent research (Pantera *et al.*, 2013, Pantera *et al.*, 2014), with emphasis on the target group directly affecting and be affected by it, namely the animal breeders. Similar work was done for the prefecture of Evritania (Pantera *et. al.*, 2003). The area is not developed economically and most people are mainly occupied in agriculture and/or husbandry. Interestingly, local people place a high economic value on these systems and are not willing to accept any change in their economic activities within the forest. Similarly, children of ages 7-17 appreciated and valued the system with the younger ones of elementary school expressing the highest interest on the forest in general. This is important since any type of conservation would be in vain without the active participation, or at least compromise, of the surrounding living population. Local people suggested a number of innovations that included the collection of forest fruits, development of livestock raising and agriculture, the establishment of a cooperative to promote local products, development of Greek and foreign tourism to support local economy, advertisement of the area and its products. They also stressed the need for better protection from poaching and illegal harvesting, better support as well as better interaction with the local population and information by the local authorities/ forest service, protection of endangered local herbs from exploitation, prevention of illegal activities within the forest, management of the forest from one authority and not by three different ones as stands now, and training of farmers on new and/or traditional cultivation techniques.

4. Environmental aspects of valonia oak silvopastoral systems

The direct relationship between organic matter to carbon cycling in forest ecosystems and thus to the mechanisms of the Kyoto Protocol (KP), raises the urgent need to estimate the dry biomass of different forest species. For this purpose Zianis and Mencuccini (2003), have compiled and analyzed biomass allometric equations on a global scale, whereas Ter-Mikaelian and Korzukhin (1997), report a great number of equations used for biomass estimation of north American forests. For Europe, Zianis *et al.* (2005) collected 607 biomass equations from papers published at scientific journals, conference proceedings, scientific annals etc., within the framework of the E.U. program COST E21. For Greece, a limited number of studies on forest biomass assessment have been conducted so far, which, however, do not meet the needs arising from the mechanisms of the Kyoto Protocol. Tsiouvaras (1978) and Parissi (2001) have developed allometric equations that relate dry biomass of annual oak twigs (*Q. coccifera* L.) in a shrubland of the Serres prefecture and to *Morus alba* L., *Colutea arborescens* L. and *Amorpha fruticosa* L. in Thessaloniki, Greece respectively, to their diameter (*D*) and/or length. Zianis and Mencuccini (2003) have developed allometric biomass equations beech trees (*Fagus moesiaca* Cz.) of the Municipal Forest of Naousa (mount Vermio, N. Greece), whereas Mitsopoulos and Dimitrakopoulos (2007) have estimated the fuel biomass of the Aleppo pine crown forest in Evia. Recently, Zerva and others (2008), estimated the root system biomass of beech stands in forest of Paiko mountain (northern Greece. However, no research has been undertaken so far in order to estimate the biomass (*M*) of oak silvopastures per unit area (biomass ha⁻¹) through the statistical analysis of field measurements. In a recent research (to be published) a methodological approach was developed based on Bayesian and classical statistical analysis, to derive allometric equations relating *M* to *D*. These empirical equations were applied on the diameter distributions of valonia oak trees recorded in forest management, to estimate *M* per

unit area (biomass ha⁻¹) and in turn the aboveground carbon stocks in the studied silvopastoral system (Zianis *et al.*, 2015).

The dendroecological study and the integration of certain natural and anthropogenic factors affecting tree growth may highlight the effect posed to valonia oak silvopastoral systems in the past due to various interventions (farming, silvicultural treatments) or environmental factors (forest fires, climate change, etc.). It also may contribute to the viability study of these systems in the future in the light of climate change. It may also identify historical events through the study of valonia oak tree-rings, the construction of growth models, the development of the relations between tree-ring width to climate, and their biological interpretation. Based on the dendrochronological analysis conducted in valonia oak stands in the Xeromero forest, the ages of the older trees exceeded 400 years, mean radial growth was low and did not differentiate significantly with age whereas tree-ring mean sensitivity was important and indicated that the species can be used for dendrochronological studies (Papadopoulos and Pantera, 2013). The history of tree-ring growth showed that these old-aged trees were exposed to various human activities and environmental influences.

5. Conclusions

The results from the ARCHIMEDES III research project will, under the framework of sustainable development and environmental protection, give a new perspective on the use and protection of the remaining valonia oak silvopastoral systems. These systems, found in economically poor areas, will positively contribute to the income of the local populations, preventing urbanization, suggesting new products and highlighting the traditional ones. Valonia oak silvopastoral systems hold a high economic, social and cultural value. Their sustainable development and management have to take into account local population respecting their needs and traditions. Various actions are being proposed among which the education and training of farmers in sustainable management of silvopastoral systems and an integrated use of the products including dairy and meat that could be as well certified as organic. The promotion of these local products is of major importance and farmers have to be supported in this by local authorities and the agricultural ministry as well. Local products must be specifically identified by fortifying their quality and origin by a brand name. Acorns are valuable animal feed and planting material, with increased demand from forest nurseries around the country, and an environmental legacy for the production of organic dyes for use in tanning industry again in the future. Another use arises lately for these systems for eco-touristic purposes as they offer a variety of activities and products to the visitors. The results can also be applied in other countries where there traditional valonia oak silvopastoral systems are met such as Turkey and Israel. These proposals and conclusions will be widely distributed to all interested parties such as institutions and agencies involved in forestry and the natural environment. The main agencies of interest are the Hellenic Forest Service and local authorities of areas where valonia oak forests grow, as well as private forest owners who wish to protect and manage them for multiple purposes (forestry, farming, environment, ecotourism, etc.). There is a growing interest in this particular oak species from investors and companies interested in extracting organic dyes from the acorns, in organic farming and agroforestry. It should be noted the expression of interest and subsequent cooperation of the Department of Forestry and NEM of TEI Sterea Ellada with the ecological organizations (non-profitable) Association of Friends of Oak and the Environment and the association "Amalthea", as well as the local prefecture of Aitolokarnania and the municipality of the island of Kea (Tzia). In this context, particular value will have the new information that will emerge on the management of oak silvopastoral systems taking into account the need for sustainable development and the impact of climate change. Finally, the knowledge acquired by this research will add to the science of agroforestry.

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