

## CONTRIBUTION OF THE EXTENSION OF ROTATION TO ECOLOGY AND PRODUCTIVITY IN A GREEK OAK COPPICE FOREST

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**ABSTRACT** - The coppice forests cover 48.0% (about 1.6 million ha) of the total forest area of Greece.

They are low productivity forests and have suffered for a long time from degradation processes. The objective of this research is to evaluate the extension (doubling) of the rotation in an oak coppice forest on carbon sequestrate and wood products. The study area is a private forest enterprise in the Prefecture of Pieria (Northern Greece) (elevation: 100-350 m). The forest covers 1917 ha, and the dominant species is *Q. frainetto*. The management system is based on clear cutting (20 years rotation) with standards (12% reserve trees) and the main product is the fuel wood. The forest was classified and divided according to the site quality (good, moderate and bad). Taking into account the current yield tables - current and mean annual increment - the rotation is determined to 20 years for the good and moderate sites. However, due to many considerations of issues such as extensive exploitation, site degradation and carbon sink issue, the extension of the rotation is proposed from 20 to 40 years. At a 60 years transitional period and just after 20 years in this period, it is estimated that the wood storage will be multiplied by three (from 31,044 m<sup>3</sup> to 106, 311 m<sup>3</sup>) and at the end of this period will be duplicated (66, 618 m<sup>3</sup>). Additionally, in the beginning of the extension of the rotation the wood production will decrease (from 2700 m<sup>3</sup>/year production today to 1211 m<sup>3</sup>/year), while in the next 10 years the increment will be the same (2850 m<sup>3</sup>) and until the end of the transition period will be redoubled (4489 m<sup>3</sup>). Furthermore, there is an improvement of the quality of wood products (higher proportion of round wood).

**KEYWORDS** - Forest management, coppice, oak forest, extension of rotation.

### INTRODUCTION

Forests under coppice system in the Mediterranean region have significant present (Greece 48%, Italy 63%) and the coppice system, with different rotation, varying from less than 10 to over 30 years, has been and still is applied to broadleaved forests, from oaks to chestnut and beeches (Morandini, 1994).

While the total area of Greece is 13.2 million ha, greek forests and forest vegetation areas cover about 6.5 million ha (49.4%). About 1.6 million ha (48.0%) of the greek forests are under coppice management, which reflects its low qualitative and quantitative production, as well as a devastation process (Dafis, 1966; Hatzistathis, 2000; Thornley, 2000). The majority of these forests (1.5 million ha) are by oak of 12 different species. They are growing in hilly areas above the order of olive belt (zone) and are characterized as oak zone (Associations of *Quercetalia ilicis* and *Quercetalia pubescentis*) (Theodoropoulos, 1991; Petermann, 1999).

Since the coppice system was applied in the forests and until today, many parameters have changed leading to the abandonment of the above mentioned management system. This results on one hand to high risks for the forests (accumulation of biomass - wild fires), and on the other hand to lack of exploitation of natural (renewable) resources. The international trends on coppice forests consist in the maintenance of the coppice system by the elongation of the rotation and the interruption of exploitation allowing them develop naturally or convert to high forests (Morandini, 1994).

The objectives of the present research is the determination of rotation in a coppice (oak) forest, the extension of the felling cycle (rotation) and study of repercussions of the above mentioned extension on wood storage (carbon sequestration) and on wood products in the coppice forest.

#### MATERIAL AND METHODS

For this, the private forest enterprise of Kastania "Notio" in the Prefecture of Pieria (Macedonia Region, Northern Greece) was selected for this research. Kastania village is a part of the Municipality of Kolindros and it is 60 km far away from Thessaloniki (FIGURE 1).

It is located in the north-eastern hills of Pieria Mountain, in the altitude of 100 - 350 meters. From a geological point of view, the study area belongs to the "Axios zone" and the substrate is tertiary deposits, i.e. marls. The soil type is rendzina or gray calcic soil with profile Ao-A1 (gray) and C (light). Due to the lack of local meteorological station in the study area the data of the meteorological station of Katerini (tobacco station of Katerini, period 1990-'99) was used. According to the before mentioned data in the area the average total rain is 618 mm, while the average annual temperature is 15.6 °C (TABLE 1).

The climate is characterized as typical mediterranean with two clearly distinct annual periods: warm and dry period (summer) and mild and wet period (FIGURE 2).

The dominant vegetation type in the region is the deciduous broad leave formation having as representative species the hungary oak (*Quercus frainetto* Ten). In the eastern lower part of the study area and in the restricted areas the dominant vegetation type is the evergreen formation (kermes oak, hornbeam, manna, etc.) and the white oak (*Quercus pubescens* Wild) can be found. The riparian forest consists mainly of oriental plane (*Platanus orientalis* L.), white poplar and willows, whereas sporadically groups of silver lime on slopes can be found. The under study oak forest has been continually covering the energy needs of the local people and only after the end of the civil war has been managed on the basis of management plans



FIGURE 1 - The study area of oak coppice forest in Kastania, Prefecture of Pieria (Macedonia, Greece).

(every 5 years). Today, the forest is managed by 20-year rotation and the management system is clear cutting with standards (12% reserve trees). The main product is fuel wood and less charcoal, etc.

The total forest area is 1917 ha, but the forest covers 1297 ha (67,6%). The forest area (1917 ha) is divided into 9 sections and 24 sub-sections or stands (Forest Management Plans, 1979-1998). Within every individual geographic divisions there

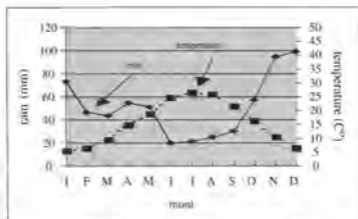


FIGURE 2 - Obrothermological diagram of the study area in Katerini (period '90-'99, elevation 40 m).

is a range of ecological types, site capacities (in terms of timber productivity) and production process practices. The current division system makes the analysis of the ecological parameters and the application of an ecologically based management very difficult. Therefore, for the aims of this research, the forest area has been reclassified and divided according to the ecological principles, concluded from researches by the Greek Ministry of Agriculture (Forest Commission). Relying on this data, the old division system has been replaced by a new which has three site types (or site classes), called S1, S2 and S3 (FIGURE 1) (Barbour *et al.*, 1998). The first site class (S1) covers 321.4 ha (24,22%) and represents the lower slopes and valley bottoms which has a low relief and deep soils. The second site class (S2) has 873,1ha (65,79%) and covers the slopes and ridges. The third site class (S3) is 132,7 ha (10,00%), outside of this study area, refers to degraded natural vegetation areas. A part of the S3 has been reforested as a plantation around the local village (Kastania). The main data for this research was derived by the growth-and-yield tables of Kossenakis (1936), which are still in use by the Forest Service until today, and by the management plan of the forest enterprise in Kastania-Greece (1979-1998). The new wood storages and exploitations are estimated by two conditions: 1) the clear cut surface (section, site quality, etc.), theoretically the same size every year, is accounted as  $1/40$  - in case of the first alternative- instead of  $1/20$  which is until today, 2) the wood production are coming from thinnings at the age of 20 years, 30 years and the final cuts at the age of 40 years. The thinnings intensity is calculated at the 15% of the current wood volume.

## RESULTS AND DISCUSSION

### *Site quality and rotation*

The current sub-division system of the forest by management units (stands) is based on physical and technical borders, such as forest roads. Within every individual geographic divisions there is a range of ecological types, site capacities (in terms of timber productivity) and production process practices. This division system and especially the short rotation (20 years) for all sites is the cause of the fact that the ecological parameters analysis and the ecological management applications have a lot of difficulties, while it is well-known that the rotation depends on the species, the management system and the site class (Dafis, 1989).

Based on the yield tables (Kossenakis, 1936) and more specifically on the current and mean annual increment (Bachmann, 1968), the rotation was defined for the coppice forest in Kastania, too. Thus, at the entire study area and in both sites (good site S1 and moderate site S2), the rotation is estimated between 20 and 22 years (FIGURE 3).

The proposed rotation for both two site classes (S1 and S2) in the coppice forest of Kastania is 40 years - double than it is today. The reasons for such a proposal are 1) the limited (socioeconomic) impacts to the current management system, 2) the expected positive effect on wood storage and carbon sink in the forest and 3) the improvements in forest ecosystem, due to less frequent exploitation.

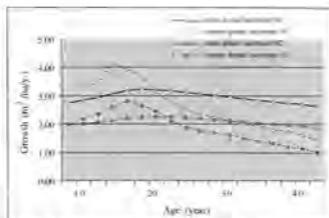


FIGURE 3 - Estimation of rotation in site classes S1, S2 according to their mean and current annual increment.

#### *Felling series and rotation (extension) in coppice forest*

Up to now the method of annual cuttings (coupes) is well known from the management practice on coppice forest. Each annual cutting extends equally on the fraction of the total surface ( $F$ ) of the coppice forest to the applied rotation ( $U=20$ ). Due to the fact that in the study area -a coppice forest- a doubling of the rotation is proposed, the annual cuttings will have now the half the area ( $F/2U$ ) it occupied before. In addition, for the next 20 years and for the 20 and 30 years old stands only forecasted thinnings (extraction of 15% of the storage) are proposed and in an area equal with the old annual cuttings ( $F/U$ ), so that they could cover the constant needs of the residents (firewood, etc.). The clear cutting (in stands 40 years old) begin after that period, until this is applied to the managed forest. From the proposed extension, it is presumed that the harmonization of the annual cuttings will be completed after 60 years (2064).

Experience in coppice forest has proved that attention should be paid on the type and the intensity of thinning and on the decaying of forest and its health after the extension of the rotation (conversion process) and especially in the moderate sites.

#### *Extension of the rotation and wood stock (carbon) changes*

Based on the growth-and-yield tables for the coppice forests (Kossenakis, 1936) and the assumed stopping of the clear cuttings for the next 20 years, a spectacular accumulation (three times more) of above ground wood stock takes place (FIGURE 4). More specifically, in the moderate sites (S2), the mean wood storage per hectare amounts at the beginnings to 23,63  $m^3/ha$ , at age of 20 years to 80,69  $m^3/ha$  (culmination/multiply by three), and at the end of the transition period amounts to 50,62  $m^3/ha$  (redoubling), while the corresponding data for the good sites (S1) is 32,41  $m^3/ha$  at the beginning, 111,57  $m^3/ha$  at the age of 20 years (culmination/multiplication by three) and at the end becomes 69,74  $m^3/ha$  (two times). At the end of the transitional period (after 60 years), the doubling of the rotation for the managed forest (best and moderate sites) implies the times of the doubling of the wood storage.

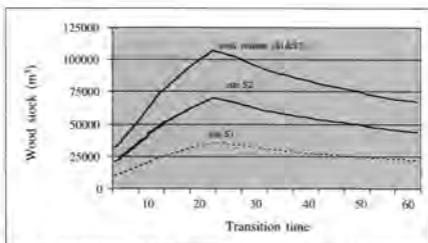


FIGURE 4 - Wood stock changes after the extension of rotation (doubling) in the private forest of Kastania.

Consequently, the total sum of the wood storage (the above ground biomass) in both site classes will double (from 31.044 m<sup>3</sup> today to 66.618 m<sup>3</sup> in 60 years).

#### *Extension of the rotation and wood production*

Today, the production of coppice forest includes products such as round wood (mainly from silver lime), commercial firewood and firewood for local consumption, sticks and charcoal. From the yearbook of production of Forest Service in Pieria Prefecture results that the total 20 year production amounted 45,000 tons, while in the interval period of 1979-1998 (20 years) amounted 2250 tons or 2700 m<sup>3</sup> in each year. During the extension of the rotation there might be a period (10 years) with less wood products.

This status will cause some socioeconomic difficulties to the local people and to the forest owners. Therefore it is proposed, as a compensation measure, thinning in 20 and 30 years old stands (cutting 15% of the wood stock). When 20-year-old stands are managed according to the proposed coppice system (doubling the rotation), as appears in FIGURE 5 a small gap of the wood production is observed at the beginning (1211 m<sup>3</sup>), then increased to 2850 m<sup>3</sup> (like the real wood production per year) and in the next time the increment will be more than double (4489 m<sup>3</sup>). A certain improvement is expected in the quality of the products i.e. higher proportion of round wood than firewood.

#### CONCLUSION

Up to now the extensive application of coppice system in Greece is connected to silvicultural practices and management decisions of doubtful effectiveness. More specifically the current short rotation (20 years for private and 30 year for state), which is applied to the most oak forests, raises a strict criticism. Nevertheless, for-

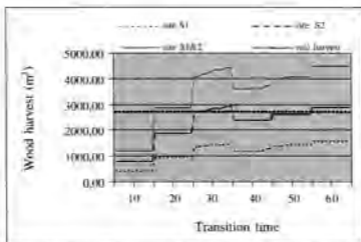


FIGURE 5 - Wood production during the extension of rotation (double) in the private forest of Kastania, Noño.

est owners and forest service do not find solution, thus applying old prescriptions and practices, despite the realization of important role of the forests today (climatic change, the role of forest as carbon sink, etc.). The present research reaches the conclusion that it is useful and easy to extend the rotation time of the coppice forests from 20 to 40 years. Then, a transition period of 60 years is follows, where at the first 20 years is observed an accumulation of biomass with a decrease of wood revenues (timber) at the beginning. However, immediately afterwards, comes a period of adaptation with increment revenues, accompanied by positive results for the forest ecosystem (less frequent disturbance) and for the environment (two times more above ground biomass - carbon sequestration - reduction of CO<sub>2</sub> in the air).

It is true that socio-economics difficulties are expected during the first 10 years, due to the lack of forest profits. The thinnings, which will start immediately at 20 years old stands, reduce the problem but without solving it. Therefore, equalizing amends are suggested for the first 10 years; those could be derived from any group that is concerned with the carbon sequestration inside forests (for example UNO, EE, etc.) (Grigoriadis, 2002). The advantages of carbon sequestration inside mediterranean forests and especially greek, where half of the forests - almost 1.200.000 ha - are coppice, are significant. The underground carbon concentration should, also, be considered, which at the moment occur but are not calculated here.

The present research concludes that the extension (doubling) of the rotation in the coppice forest and the extrapolating are expected important outcomes at all the scales of the forest and the environment at regional and national level. Moreover, support measures to any concerned group (forest owners, forest workers, etc.) are foreseen in any form (economic, jobs, etc.), especially for the first interval period (10 years). Such frame of support is already offered today by the European Union through several programs of the Ministry of Agriculture or of the Ministry of Environment (guidelines for protected areas, etc).

## RIASSUNTO

I querceti cedui in Grecia coprono il 48% della superficie forestale (circa 1,6 milioni di ettari). Questi querceti cedui sono di bassa produttività e da molto tempo soffrono di degradazione. In Grecia esistono 12 specie indigene di quercia, le quali includono tipi di quercia caducifolia e di quercia sempreverde, con una grande ampiezza di esigenze di ponderazione. Uno dei tipi più importanti è la quercia latifolia (*Quercus frainetto* Ten.). L'oggetto della ricerca è la valutazione dell'allungamento (raddoppiamento) del turno di taglio di un querceto ceduo e delle sue conseguenze sulla fissazione di carbonio e sui derivati prodotti del legno.

L'area della ricerca è un terreno boschivo di proprietà privata nella Prefettura di Pieria (Grecia del Nord) (altezza sul livello del mare: 100-350 m). Il bosco copre 1.917 ettari e la specie prevalente è la quercia latifolia (*Quercus frainetto* Ten.). Il terreno boschivo si trova sotto lo stesso sistema di gestione selvicolturale da varie decenni. Il sistema di gestione selvicolturale include tagli di disboscamento con un turno di 20 anni, ceduo con ritenute (12% di ritenuta) e il prodotto più importante è il legname. L'area di ricerca è stata suddivisa secondo la sua produttività in stazioni efficienti, mediane e inefficienti. Considerando i quadri di produzione ritenuti validi fino a oggi - soprapprezzo medio e attuale - il turno di taglio era stato definito in 20 anni per le stazioni efficienti e mediane. Comunque, per mitigare il disturbo causato dallo sfruttamento intensivo del bosco, dal suo degrado e dal rilascio di carbonio nell'aria, viene proposto l'allungamento del turno di taglio da 20 a 40 anni. A questo scopo, è necessario un periodo transitorio di 60 anni; in questo caso, 20 anni dopo viene osservata la triplicazione delle riserve di legname (da 31.044 metri cubi a 106.311 metri cubi) e alla fine la quantità viene raddoppiata (66.618 metri cubi). Inoltre, durante l'inizio di questo periodo, la produzione di legname viene ridotta (da 2.700 metri cubi a 1.211 metri cubi), 10 anni dopo ritorna alla quantità iniziale (2.850 metri cubi) e poi fino alla fine del periodo transitorio viene raddoppiata (4.489 metri cubi). Inoltre, è atteso il miglioramento della qualità dei prodotti derivati (incremento della proporzione di tonname).

PAROLE CHIAVE - gestione selvicolturale, ceduo, querceto, allungamento del turno di taglio.

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