

Intelligent Pubescent Oak Forests (*Quercus Pubescens* Willd.) From Dobroudja Plateau, Romania

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Abstract

Dobrudjea Plateau, located in south-east Romania, is characterized by low altitudes, old rocks, a temperate-continental climate and a silvosteppe and steppe vegetation. Pubescent oak is one of the tree species characteristic for this area. With average dimensions, this tree fulfils numerous ecosystem functions.

The concept of “Climate-Smart Forestry – CSF” is recent and was adapted in this article for the pubescent oak characteristic for this area; clear and measurable criteria were also identified and applied for this species in order to identify the smart stands.

Smart pubescent oak forests represent 3% of all this species’ stands and are more common in the north part of Dobrudjea Plateau. They are characterized by advanced ages (61-70 years), 20%-30% compositions and even-aged structures. The forests are located on relatively small distances from forest roads, at altitudes of 100m - 250 m, and on west and east expositions.

The present study has showed that smart pubescent oak forests can be established by taking into account 14 site (flora, soil or forest type) and stand conditions (pruning, vitality, average diameter and height, functional group and category, litter). The identification of these stands is extremely important for their protection as well as for applying the appropriate silvicultural measures.

Keywords: pubescent oak, smart forests, altitude, structure, age

1. Introduction

Dobrudjea Plateau occupies 4.3% (approximately 12.000 km²) of Romania’s surface and is situated in the country’s south-east part. This region is bordered by the Danube in north and west, by the Black Sea in the east, by Danube’s Delta in north-east and by the Bulgarian border in south. The area conserves some of the country’s oldest relief forms and structures formed on old rocks (green schists, granite), calcar, slate and loess (Popescu N., and Ielenicz M., 2003; Caraivan, G et al., 2011; Prăvălie, R., et al. 2014a). From a morphologic point of view, the studied area is characterized by low altitudes in the center and south-west parts (89% are under 200 m), with altitudes over 400 m located in the north-part, namely in Măcin Mountains. (Ielenicz M., 2003). From a climatic point of view, this area is situated within the temperate-continental climate. As such, the average annual temperature ranges between 10.7-12.12°C, while the annual average precipitation quantity is low, under 400 mm/an, being one of Romania’s most arid zones (Manole, D., et al., 2018; Maftai, C. 2015). The most widespread soil types from this area are represented by different chernozems and phaeozems, complemented by luvisols (preluposol) and cambisols (eutric cambisol) (Marin, I., 2003; Nicolaescu, M., et al., 2009; Spârchez, G. et al., 2017; Dincă, L., et al., 2018). The silvosteppe and steppe vegetation are representative for this area, while the most common forest species are: *Quercus pubescens*, *Fraxinus ornus*, *Carpinus orientalis*, *Quercus pedunculiflora*, and *Tilia tomentosa* (Marin, I. 2003; Geacu, S. et al., 2018; Onet, A., et al., 2019).

Pubescent oak (*Quercus pubescens* Willd.) is a Mediterranean species, widespread from South Europe towards north (France, South Germany) and east (Czech Republic, Slovakia and Romania). The species is present in our country in pure stands or mixed with other species, being present in the silvosteppe area as well as scarcely in Transylvania’s Basin (Milecka, K., et al. 2004; Șofletea, N., & Curtu, L. 2007; Wellstein, C., & Spada, F. 2015). *Quercus pubescens* Willd. reaches average heights (15-20 m), and has a thick, black and hard rhytidom. The leaves are characteristic for this species, being tomentose on both sides initially and then only on the back, while the acorn’s cup is sessile or shortly pedunculated (Șofletea, N. & Curtu, L. 2008; Șimonca, V., et al., 2019). The species

has a rare fructification, at an interval of 5-7 years, which leads to a slow regeneration (Şimonca, V. et al 2019).



Figure 1. Distribution of pubescent oak

https://en.wikipedia.org/wiki/Quercus_pubescens#/media/File:Quercus_pubescens_range.svg

Forest stands have numerous ecosystem functions, such as: producing numerous non-wood products (Tudor, C., et al., 2019; Dincă, L. & Timiș-Gânsac, V. 2020), game and fish species (Ciontu, C., et al., 2020), and forest fruits (Vechiu, E., et al., 2019).

Recently, the most frequent climatic changes are represented by temperature increases and the decrease of precipitations, leading to changes in the forest ecosystems. Romania is one of the countries that has to deal with these climatic changes, so their impact is of major interest for the scientific communities looking to diminish them (Marin, L., et al., 2014; Pravalie, R. et al., 2014b; Constandache, C., et al., 2018; Dincă, L. & Achim, F., 2019). Over time, many concepts were described and used in evaluating and creating solutions for the management of adapting and diminishing climatic changes. The concept of “Climate-Smart Agriculture” has led to the concept of “Climate-Smart Forestry – CSF” which is still not clearly defined but which concentrates on the following purposes: reducing hothouse gas emissions, reducing stand vulnerabilities and the durable increase of stand productivity (Bowditch, E., et al., 2020; Verkerk, P., et al., 2020). The majority of studies realized up until now have focused on reducing hothouse gas emissions through modelling techniques and their impact on the climate. As such, implementing CSF is necessary in helping managing forests under climatic changes, based on their socio-ecological purposes (Bowditch, E., et al., 2020; Yousefpour, R., et al., 2018; Nabuurs, G., et al., 2018).

The purpose of this article is to identify and describe smart pubescent oak forests located in Dobruja Plateau Romania.

2. Method

The inventory and description of Romanian forests is realized every 10 years, when forest management plans are created. These plans contain silvicultural parcels (portions of homogenous forests confined by the field), as well as all environment and stand characteristics. The present article has studied data from 9 forest management plans realized during 1994-2009 (Forest management plans, 1994-2009), from where 1666 pubescent oak stand elements were extracted. Only stands over 40 years were taken into account as the younger one cannot be framed in the smart forests category.

As such, fourteen stand elements (pruning, vitality, average diameter and height, production class, current growth, structure, consistency, production subunit, functional group and subgroup, litter) and site ones (flora, soil or forest type) were studied. Each element has received a grade from 1 to 5 based on the specie’s ecological and silvicultural requests, where 1 = very low; 2 = low; 3 = average; 4 = high; 5 = very high (Table 1). A total grade was obtained by adding all values for a stand, followed by their ordering.

Table 1. Grades obtained based on the stand's or environment's characteristic

Crt. no.	Characteristic	Grade				
		1	2	3	4	5
1	Pruning	0.2-0.3	0.4	0.5	0.7	0.6
2	Vitality	5	4	3	2	1
3	Average diameter (cm)*	6-12	14	16-18	20-22	24-38
4	Average high (m)*	1-6	7-8	9	10	11-19
5	Production class	5	4	3	2	1
6	Current growth (m ³ /year/ha)*	0.1	0.2	0.3	0.4-0.6	0.7-2.9
7	Structure	1	2	3	4	
8	Consistency	0.3-0.4	0.5	0.6; 0.9	0.8	0.7
9	SUP	Q	A	V	K	E, M
10	Functional group + Functional category	1,3G ; 2,1C	1,3A; 2,1B	1,2B; 1,5L	1,2A;	1,5C; 1,5D
11	Litter	1	2	3	4	5
12	Flora	53	52; 74	65; 68; 72; 75	61; 71	51
13	Soil type	1215;170 39604	1210; 1701; 2205	1204;	1301; 1401	1201
14	Forest type	5162	5325 ; 5333 8223; 8224	7531; 8112 8521	8212	

*For this characteristic, the entire value range was divided in 5 categories, where 1 = the lowest (ex: average diameter between 10-16 cm), 5 = the largest (ex: current growth higher than 2.8 m³/year/ha) with grades being given for all categories. The category division was realized to respect the analyzed biometric characteristics, as well as to ensure a balanced division as value number for each category.

The meaning of the terms from Table 2 is rendered below:

Vitality: 1 = very vigorous; 2 = vigorous; 3 = normal; 4 = weak; 5 = very weak.

Structure: 1= even-aged stands; 2 = relatively even-aged stands; 3 = relatively uneven-aged stands; 4 = uneven-aged stands.

Production/protection subunits (SUP) (excerpt): A = Regular forest, common assortments: wood for timber, constructions, celluloses; E = Reservations for the integral protection of nature; K = Seed reservations; M = Forests under the extreme conservation regime.

Functional group (GF) and functional category (FCT) (excerpt): 1,2A = Forests located on cliffs, debris, on fields with depth erosion, on fields with a slope higher than 35 degrees or 30 degrees for those situated on flysch, sands or gravels; 1,3A = Steppe forests, from the limit between steppe and silvosteppe; 1,3G = Bodies of dispersed forests, with surfaces under 100 ha, situated in plain areas; 1,5C = Natural reservations; 1,5D = Scientific

reservations; 1,5L = Forests from reservation's protection areas (bumper areas); 2,1B = Forests meant to produce thick trees of superior quality for timber; 2,1C = Forests meant to produce average and thin trees for celluloses, rural constructions or other usages.

Litter: 1 = missing litter; 2 = narrow intermittent litter; 3 = narrow continuous litter; 4 = normal continuous litter; 5 = thick continuous litter.

Flora: 51 = *Asarum-Brachypodium*; 52 = *Carex pilosa*; 53 = *Luzula albida-Carex montana*; 61 = *Asarum-Stellaria*; 65 = *Festuca altissima*; 68 = *Luzula albida*; 71 = *Erachypodium-Geum-Pulmonaria*; 72 = *Poa pratensis*; 74 = *Carex brizoides-Agrostis alba*; 75 = *Carex riparia-Iris pseudacorus*.

Soil type: 1201 = chernozem; 1204 = rendzic chernozem; 1210 = vermic-stagnic chernozem; 1215 = lithic-rendzic chernozem; 1301 = cambic chernozem; 1401 = phaeozem; 1701 = rendzina; 1703 = lithic rendzina; 2205 = stagnic preluvisol.

Forest type: 5162= Holm stands with oriental hornbeam of inferior productivity; 5325= Silvosteppe tug with holm; 5333= Dobrudjea tug of interior productivity; 7531= Turkey oak-tug of Dobrudjea tug; 8112= Pure brown oak on weakly degraded cernoziom with loess substratum; 8212= Pubescent oak on profound soil; 8223= Pure pubescent oak from the Dobrudjea silvosteppe with superficial soil; 8224= Silvosteppe pubescent oak with oriental hotnbeam; 8521= Dobrudjea oak tug with brown oak and pubescente oak.

3. Results and Discussion

Taking into account the fact that smart forests represent up to 10% of the total forests from an area, if we order down the grade obtained by each pubescent oak stands from Dobrudjea Plateau, we can consider that this category contains forest with a grade higher than 46, meaning 46 stands. Unlike smart spruce stands from the Southern Carpathians (Dincă, L., et al., 2019), the pubescent oak ones from Dobrudjea Plateau have a lower percentage similar to alder stands from the Southern Carpathians (Blaga, T., et al., 2019) or manna ash (*Fraxinus ornus* L.) from Banatului Mountains (Dincă L., et al., 2020).

The following elements can be observed by analyzing certain characteristics of these 46 smart forests (Table 2):

Table 2. Characteristics of the pubescent oak smart forests from Dobroudja Plateau

Crt. no.	Forest District	Age (years)	Altitude (m)	Exposition	Percentage (%)	Structure	Distance from the road (km)
1	Ciucurova	70	212	E	30	1	19
2	Ciucurova	80	140	N	30	2	1
3	Babadag	100	695	E	10	2	1
4	Constanta	50	140	Plane	50	1	7
5	Babadag	65	220	Plane	70	1	5
6	Cerna	70	320	SE	40	1	48
7	Cerna	70	270	SV	40	1	46
8	Ciucurova	70	110	V	20	1	2
9	Baneasa	85	140	E	90	1	28
10	Ciucurova	90	240	V	70	2	20
11	Constanta	50	140	Plane	30	1	9
12	Cerna	60	180	S	30	1	39
13	Babadag	65	120	N	90	1	4
14	Cerna	65	200	E	20	1	7
15	Babadag	70	120	N	40	1	1
16	Ciucurova	70	200	S	70	1	11
17	Ciucurova	70	120	V	20	1	3
18	Baneasa	85	140	E	90	1	27
19	Ciucurova	90	220	E	100	1	6
20	Ciucurova	90	180	V	100	1	10
21	Babadag	100	140	Plane	30	1	2
22	Cerna	60	205	SE	30	1	42

23	Babadag	65	120	V	20	3	5
24	Cerna	70	200	SV	30	1	32
25	Cerna	70	230	SE	40	1	44
26	Cerna	70	220	V	30	1	41
27	Cerna	70	200	NE	20	1	46
28	Macin	75	420	Plane	30	1	24
29	Niculitel	80	230	Plane	70	1	5
30	Ciucurova	90	230	SV	60	1	15
31	Babadag	100	155	E	10	3	8
32	Cerna	60	210	S	20	1	5
33	Cerna	60	185	SE	20	1	52
34	Cerna	60	180	SE	30	1	43
35	Cerna	60	250	SE	20	1	9
36	Babadag	65	140	N	70	3	8
37	Babadag	65	185	E	30	1	17
38	Constanta	70	100	V	20	2	25
39	Ciucurova	70	200	S	30	2	8
40	Niculitel	75	300	NE	50	1	12
41	Niculitel	75	220	E	100	1	26
42	Baneasa	85	140	S	80	1	27
43	Baneasa	85	135	V	60	1	28
44	Constanta	90	230	NE	90	1	7
45	Ciucurova	90	230	S	100	1	1
46	Niculitel	100	270	V	60	2	5

From a geographic distribution point of view, smart pubescent oak forests are present especially in Cerna, Ciucurova and Babadag Forest Districts, but can also be found in lower percentages in Constanta, Baneasa and Niculitel. However, these stands miss entirely in Cernavoda and Casimcea Forest Districts (fig. 2).



Figure 2. Distribution of smart pubescent oak forests in Dobroudja Plateau

The age of these smart forests is varied, ranging between 50 and 100 years. Very advanced old ages are not a characteristic of smart forests. The majority of these stands are situated between the 61-70 years category.

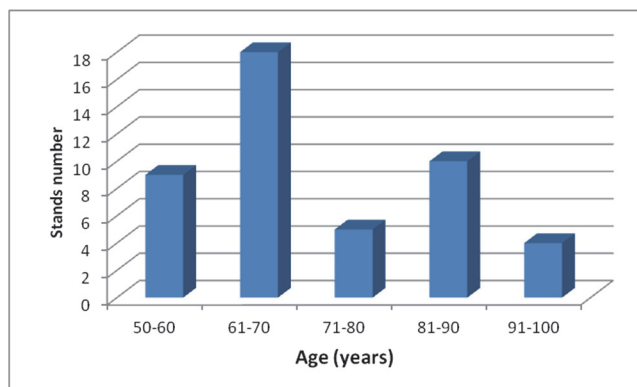


Figure 3. Distribution of smart pubescent oak forests in Dobroudja Plateau on ages

As an altitudinal distribution, these stands are situated between 100 and 695 m, mainly at altitudes of 100 and 250 m (fig. 4).

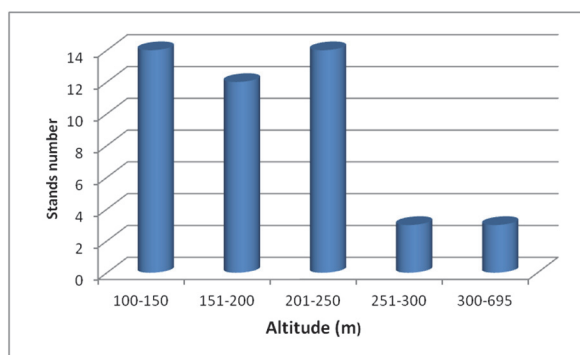


Figure 4. Distribution of smart pubescent oak forests in Dobroudja Plateau on altitudes

The west and east expositions are characteristic for smart pubescent oak forests. As the species is xerophyte, it develops well on sunny expositions and is less present on shadowed slopes (Figure 5).

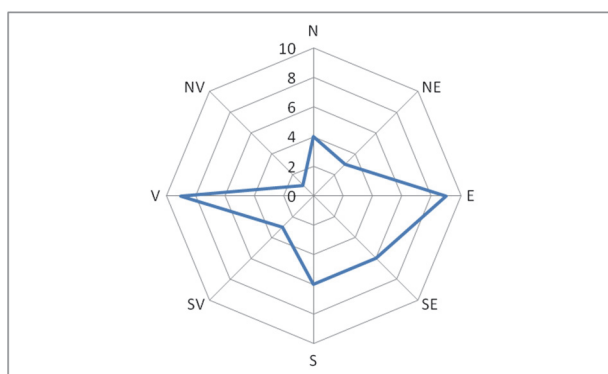


Figure 5. Distribution of smart pubescent oak forests in Dobroudja Plateau on expositions

Smart pubescent oak stands are very rarely pure stands. As such, the species enters in the stand composition in different percentages, with the most common one being of 20-30% (Figure 6).

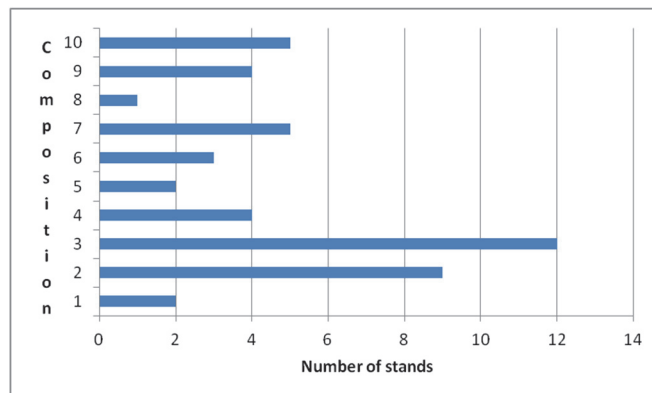


Figure 6. Participation percentage in stands compositions of smart oak forests from Dobroudja Plateau

The structure of these stands is mainly even-aged (80%), with only 13% of them being relatively even-aged and even fewer (7%) relatively uneven-aged (Figure 7).

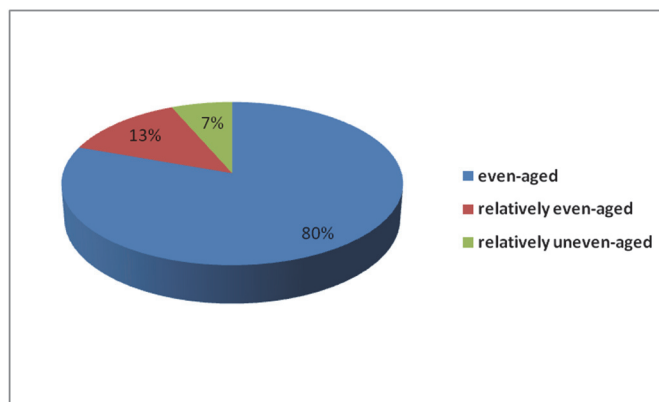


Figure 7. Distribution of smart pubescent oak forests in Dobroudja Plateau on structure categories

In regard with the distance between these stands and existent roads, the stands are situated at relatively small distances from the roads (between 1 km and 11km), with the exception of stands from Cerna Forest Districts (which are situated in the Danube Delta, so at considerable distances from the roads).

4. Conclusions

Due to the difficult ecological conditions on which they vegetate, pubescent oak stands from this area can be situated in the smart forests category only in a percentage of 3%. This number is lower than that of stands formed of Romania's main species (spruce), but is similar with disseminated species (alder).

Smart pubescent oak forests are present especially in Dobroudja Plateau north part but can also appear in the south part, although they lack entirely from the central area. These stands are characterized by ages between 50 and 100 (mainly between 61-70 years), altitudes between 100 and 250 m, west and east expositions, 20% and 30% oak participation percentages, even-aged structures and relatively small distances from forest roads.

Knowing the stand and environment characteristics of smart pubescent oak stands is extremely important for identifying these stands and for establishing the silvicultural measures needed for obtaining a larger number of these stands as well as for protecting the existing ones.

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