THE CHARACTERISTIC ELEMENTS OF OLD FORESTS FROM THE CURVATURE SUB-CARPATHIANS

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Abstract. *Forests have an important role in forest ecosystems and especially in conserving biodiversity. The present study intends to analyse and characterise old stands located in the Curvature Sub-Carpathians. Old stands have an essential role in conserving biodiversity, have a complex structure and store significant carbon quantities. The studied stands are located in a fragmented relief, being present in basin and hills, at altitudes between 500-600 m. Common beech (Fagus sylvatica L.) is one of the most common species found in European broadleaved forests with different vegetation conditions. The analysis of old stands is achieved based on the following main elements: species, surface, origin, age, average diameter, average height, volume, altitude, production class, flora, soil type, station type, slope aspect, production/protection subunits, structure and slope. Data pertaining to these elements was extracted from forest management plans realized during 1999-2007 in 10 forest districts present in the studied area. These forest districts occupy a surface of 141.191 ha, having over 371 management units older than 160 years. The main species present in the old stands from the Curvature Sub-Carpathians are: Fagus sylvatica L. (Common beech), Quercus petraea (Matt.) Liebl. (Sessile oak) and Quercus robur L. (Pedunculate oak). These species vegetate on litic luvisol and common eutric cambisol, and have an average diameter of 54-78 cm. The majority of old stands are situated within regular forests with common ranges: wood for lumber, constructions or cellulose.*

Keywords*: old grow forest, soil, forest type, age, composition*

INTRODUCTION

Forests play an essential role due to the ecosystem services they provide. Biodiversity conservation is one of the most important services offered by forests. However, biodiversity is decreasing at a global level. Old stands have an extremely essential purpose in maintaining biodiversity and they can help identify different information in the context of climatic changes (GIBSON *ET AL.*, 2011; KEETON *ET AL.*, 2011; JONES, *ET AL.*, 2018; JACTEL *ET AL.*, 2018). Old forests are mainly characterised by the presence of old and big trees, close to their natural age limit and distributed on many vegetation levels. These stands have a complex vertical and horizontal structure. Another characteristic of these forest ecosystems is represented by the fact that they store a large quantity of carbon (SPRACKLEN, 2019; 2020).

For this study, we have taken into account old stands from the Curvature Sub-Carpathians. They are situated south of the Eastern Carpathians, between Prahova Valley and Dâmbovița Valley. This region is characterised by a fragmented relief, displaying hills and valleys with a rich hydrographic network. Forests and meadows are present because of this fragmented relief, in correlation with the temperate-continental climate that has oceanic influences (GRECU *ET AL.*, 2020; MINEA *ET AL.*, 2017). These forests can be differentiated on altitude by their component species. In this way, common beech and holm are the most widespread species, having an inferior altitude limit between 300 - 400 m, while resinous stands can be found at altitudes over 1000 m (BĂLTEANU *ET AL.*, 2010).

Common beech is one of the dominant broad-leaved species from European forests. In Romania in particular, the species occupies approximately 31% of the total surface occupied by forests. Common beech can be found both in the mountain area as well as in low ones (hills), both in pure stands or in mixture ones. The species can easily adapt to different vegetation

conditions, although it prefers areas with a hot climate and high precipitation quantities (OGNJENOVIĆ *ET AL*., 2020; ŞOFLETEA & CURTU 2007; TIMIŞ-GÂNSAC *ET AL*., 2020).

Forests located in this area fulfil multiple ecosystem functions: non-wood forest products (TIWARY *ET AL*., 2020; TUDOR *ET AL*., 2019), FOREST FRUITS (VECHIU *ET AL*., 2019; TUDOR *ET AL*., 2021), animals (CIONTU *ET AL*., 2018; CIONTU *ET AL*., 2020).

The purpose of this study is to identify and characterise the main elements that are important in describing old stands from the Curvature Sub-Carpathians (Figure 1.)

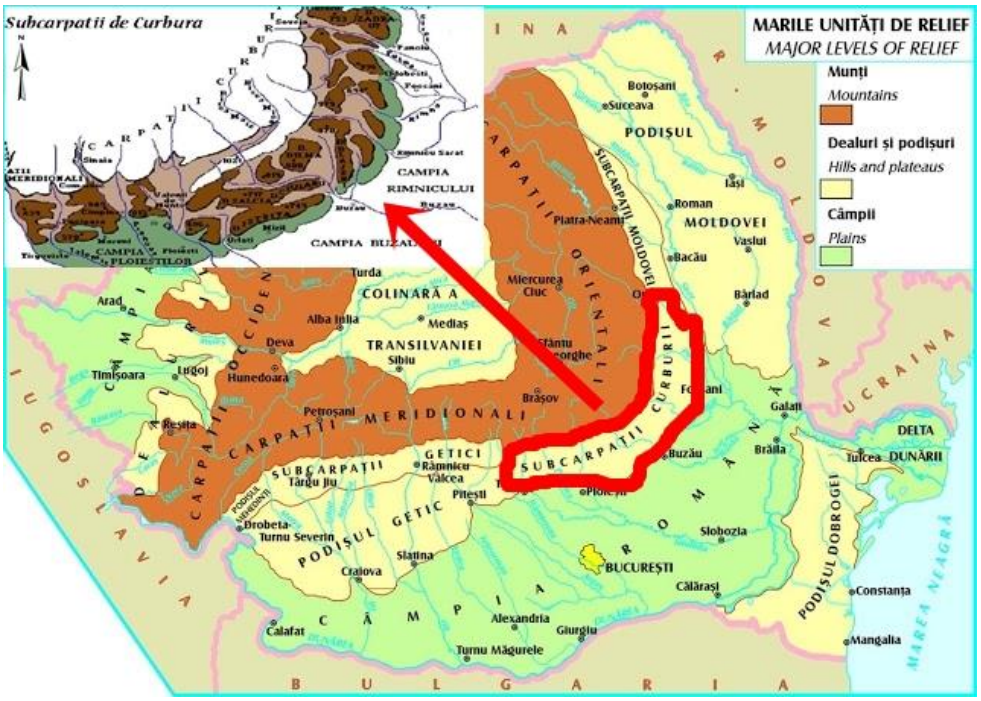

Figure 1. Location of the Curvature Sub-Carpathians

MATERIAL AND METHODS

The present paper relies on data supplied by forest management plans realized during 1999-2007 in the Curvature Sub-Carpathians (***, 1999-2007). The data was centralized for the 10 forest districts present in this area. The stand's age is established together with the forest management plan, namely once every 10 years.

This data from forest management plans refer to the following elements: species, surface, origin, age, average diameter, average height, volume, altitude, production class, flora type, soil type, station type, slope aspect, production/protection subunits, structure and slope.

The data is stored in an Excel database that allows their easy management.

The characteristics analysed within this paper refer mainly to the stands' age, followed by other characteristics such as: species, average diameter and height, surface, location, altitude, station type, soil type, litter, production/protection subunits and structure.

RESULTS AND DISCUSSIONS

The analysed data revealed that forests from the Curvature Sub-Carpathians cover a surface of 141.191 ha. The 10 forest districts that were taken into account were: Cislău, Dumitrești, Moreni, Pârscov, Pucioasa, Slănic, Văleni, Vidra, Vintilă Vodă and Voinești. Figure number 2 renders the forest districts and the surface that they cover.

As it can be seen, Cislău forest district covers the largest surface (20.178 ha), followed closely by Vintilă Vodă forest district (17.353 ha). All other forest district has a relatively similar surface coverage.

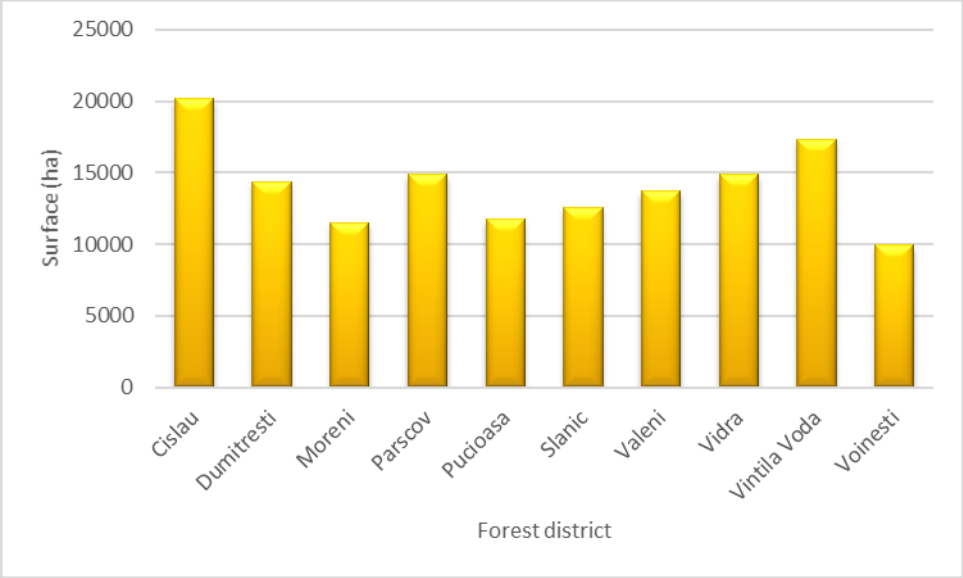

Figure 2. The surface occupied by forest districts in the Curvature Sub-Carpathians

The studied forest districts from the Curvature Sub-Carpathians contain 371 stands (UA) that are 160 years old or even older. Amongst them, 99 stands are 170 years old or even older. They occupy a surface of 909.4 ha, while seven stands that are 200 years old or even older occupy 11.4 ha. The inaccessible field from the Southern Carpathians allows the presence of more old stands (CÂNTAR *ET AL.*, 2019). The situation is similar with Banatului Mountains (TIMIȘ-GÂNSAC *ET AL.*, 2020), but different then Romania's Wester Plain where more old stands can be found (DINCĂ AND BRATU, 2020).

Table number 1 presents 30 of the oldest and most representative stands from the Curvature Sub-Carpathians. The detailed study of these stands has involved the identification of 132 elements that characterise them.

Table 1

The oldest 30 stands from the Curvature Sub-Carpathians

Forest district	Species	Surface (ha)	Age (years)	Mean diameter	Mean height	SUP	Altitude	Soil type	Flora	Station type	Litter	Structure
Dumitresti	Common beech	6.3	270	66	31	A	1050	3101	31	3333	4	3
Cislau	Common beech	0.4	250	80	28	A	898	2206	41	5152	2	3

Vidra	Common beech	3.6	210	56	18	O	585	2405	68	5131	2	2
Slanic	Pedunculate oak	0.4	200	80	23	A	285	9401	73	7520	3	3
Slanic	Pedunculate oak	0.1	200	80	26	A	285	2208	68	6264	3	3
Cislau	Common beech	2	200	60	24	M	550	4102	46	5231	2	3
Cislau	Common beech	0.3	200	60	28	A	750	3101	41	5242	2	3
Dumitresti	Common beech	3.3	190	60	21	M	600	3123	35	4120	3	3
Dumitresti	Common beech	7.8	185	56	30	A	825	3101	31	4420	4	3
Moreni	Common beech	11.4	180	62	25	A	580	3101	41	5242	4	4
Slanic	Pedunculate oak	1.4	180	70	29	A	290	2407	72	7332	4	3
Parscov	Common beech	9.4	180	64	30	A	815	3101	41	5242	4	3
Parscov	Sessile oak	8.8	180	50	23	A	495	2405	68	5131	4	3
Parscov	Sessile oak	3.7	180	54	21	A	440	2405	68	5131	4	3
Parscov	Sessile oak	23.4	180	54	20	A	465	2405	68	5131	2	3
Vintila Voda	Common beech	2.1	180	58	27	A	1065	3101	31	3332	4	3
Vintila Voda	Common beech	4.1	180	60	30	A	1050	3101	31	3332	4	3
Dumitresti	Sessile oak	1.2	180	58	24	A	515	3101	61	5152	4	3
Dumitresti	Common beech	10.6	180	64	32	A	665	1701	31	3333	3	3
Dumitresti	Common beech	4.2	180	64	32	M	665	1701	31	3333	3	3
Dumitresti	Common beech	6.5	180	64	33	A	700	3101	31	3333	3	3
Vidra	Common beech	1.7	180	62	28	M	875	3107	31	4420	3	3
Vidra	Common beech	1.1	180	50	25	M	460	2405	46	5231	4	3
Vidra	Common beech	0.2	180	48	25	M	485	2405	46	5231	3	3
Vidra	Common beech	4.4	180	52	25	A	525	2405	46	5231	4	3
Vidra	Common beech	4.7	180	54	25	O	470	2405	46	5231	1	2
Vidra	Common beech	2.5	180	52	21	O	610	2405	46	5231	2	2
Vidra	Common beech	5.4	180	56	20	O	470	2405	46	5231	2	3
Vidra	Common beech	3	180	56	20	O	540	2405	46	5231	2	2
Vidra	Common beech	5.1	180	44	20	O	630	2405	46	5231	2	2

The meaning of the terms used in the table is rendered below:

SUP (production/protection subunits): A = common forest with common assortments: wood for timber, constructions, celluloses; M = forests under an extreme conservation regime; O = fields that will be removed from the forest fund;
Soil type: 1701 = common rendzina; 2206 = mollic vertiv preluvisol; 2208 = gleyc preluvisol; 2405 = lithic luvisol; 2407 = stagnic luvisol; 3101 = eutric cambisol; 3123 = gleyc-stagnic eutric cambisol; 4102 = lithic entic podzol; 9401 = fluvisol;
Flora type: 31 = *Asperula-Dentaria*; 35 = *Luzula-Calamagrostis*; 41 = *Asperula-Asarum*; 46 = *Vaccinium-Luzula*; 61 = *Asarum-Stellaria*; 68 = *Luzula albida*; 72 = *Poa pratensis*; 73 = *Carex pilosa;*
Station type: 3332 = Mountain with mixtures, Bm, average edaphic eutric cambisol with *Asperula-Dentaria;* 3333= Mountain with mixtures, Bs, high edaphic eutric cambisol with *Asperula-Dentaria*; 4120 = Mountain-pre-mountain with common beech, Bi, rocks and excessive erosion; 4420 = Mountain-pre-mountain with common beech, Bm, average edaphic eutric cambisol with *Asperula-Dentaria*; 5131 = Hill with holm, Bi, low edaphic preluvisol and luvisol with *Vaccinium Calluna*; 5152 = Hill with holm, Bm, average edaphic preluvisol eutric cambisol; 5231 = Hill with common beech, Bi, low edaphic luvisol with *Vaccinium-Luzula*; 5242 = Hill with common beech, Bm, average edaphic eutric cambisol with *Asperula-Asarum*; 6264 = Hill with cvercete, Bs, gleyc eutric cambisol and gleisol in the high meadow; 7332 = Hill with cvercete and oak, Bm, stagnic preluvisol with *Poa pratensis-Carex carryophyllea*; 7520 = Hill with cvercete and stejar, Bi-m weakly humiferous aluviosol;
Litter: 1 = litter missing; 2= narrow interrupted litter; 3 = narrow continuous litter; 4 = normal continuous litter;
Structure: 2 = relatively even aged stand; 3 = relatively uneven aged stand; 4 = uneven aged stand.

The division on production or protection subunits (SUP) is realised within the production or protection forest management units, based on the needs and when forest section are identified with an ecological, social and economic need to be framed differently than other sections. The majority of old stands are situated within common forests with common assortments: wood for timber, constructions, celluloses (SUP A).

The main species that are present within old stands from the Curvature Sub-Carpathians are: *Fagus sylvatica* L. (Common beech), *Quercus petraea* (Matt.) Liebl. (Sessile oak) and *Quercus robur* L. (Pedunculate oak). Figure number 3 renders the found species based on the number of stands in which they are present. As such, we can observe that common beech is the most widespread species in this area as the mountain habitat is beneficial to it, while the oldest stands contain common beech as a main species in their composition. Other species from this area that are also present in other areas of our countries are alder (BLAGA *ET AL*., 2019), Norway spruce (DINCĂ ET AL., 2019), hornbeam (DINCĂ AND BREABĂN, 2020), and manna (DINCĂ ET AL., 2020).

Asperula-Dentaria is the most widespread type of flora, followed by *Luzula albida* and *Vaccinium-Luzula*. The *Asperula-Dentaria* flora is characteristic for mixture common beech – resinous forests or for mountain pure common beech stands.

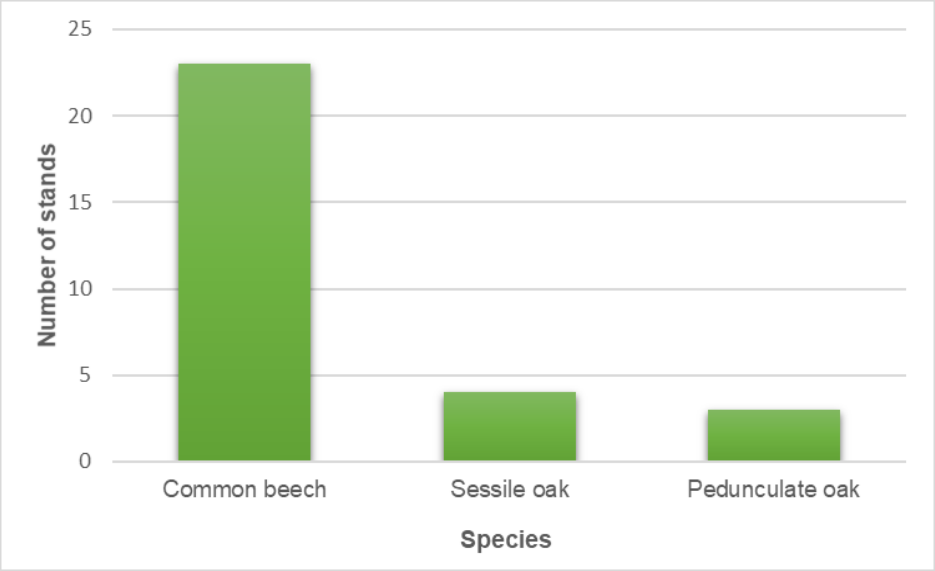

Figure 3. Distribution of species from old stands

Diameter and height are the main characteristics of a tree. In the case of the studied trees, these characteristics differ from one species to another, so that the average diameter varies between 54 and 78 cm, while the average height between 22 and 26 m (figure 4.).

Figure 4. Average diameter and height of species from the old stands

The most widespread soils from the studied stands are represented by lithyc luvisol (2405) and common eutric cambisol (3101). These soils cover a surface of 115 ha, which represents 83% of the total surface of all stands (figure 5.)

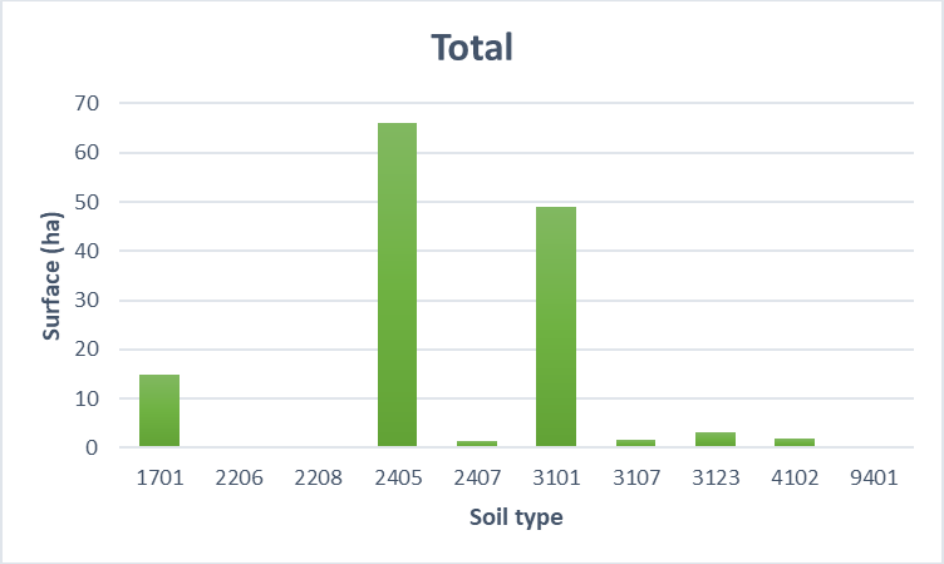

Figure 5. Soil types and the surface they cover in these old stands

The station types that occupy a significant surface are: 5131 (Hill with holm, Bi, low edaphic preluvisol and luvisol with *Vaccinium Calluna*), 5231 (Hill with common beech, Bi, low edaphic luvisol with *Vaccinium-Luzula)*, 3333 (Mountain with mixtures, Bs, high edaphic eutric cambisol with *Asperula-Dentaria)* and 5242 (Hill with common beech, Bm, average edaphic eutric cambisol with *Asperula-Asarum*). Station types are differentiated based on the soil type, slope aspect, humus and edaphic volume.

The altitude at which old stands are present in the Curvature Sub-Carpathians ranges between 285 m – 1065 m. The majority of stands are situated at 400 - 600 m (figure 6.), and are present in Pârscov and Vidra forest districts.

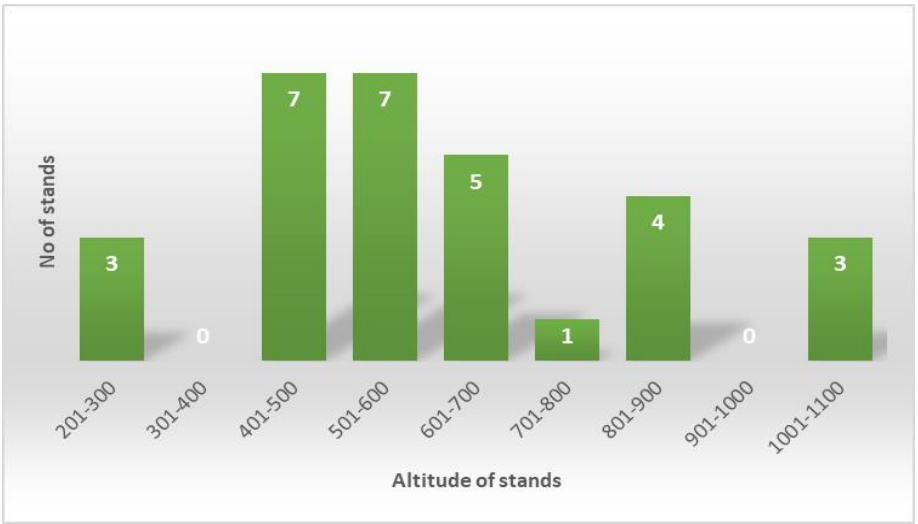

Figure 6. Altitude of old stands

The majority of old stands have a relatively uneven aged structure. Trees from different generations are characteristic to this structure. The litter (accumulation of organic remains at the soil's surface) is varied, while the normal continuous litter was the most found type in the studied stands.

CONCLUSIONS

Old forests contribute to the conservation of biodiversity, this being also the main important service offered by forests. However, biodiversity is decreasing at a global level,

The Curvature Sub-Carpathians have a fragmented relief with valleys and hills. In the conditions of such a varied relief, common beech (Fagus sylvatica L.) is one of the most widespread species as it can grow in different vegetation conditions. Beside him, the studied stands are populated by *Quercus petraea* (Matt.) Liebl. (Sessile oak) and *Quercus robur* L. (Pedunculate oak). Station types are differentiated based on the soil type, slope aspect, humus and edaphic volume. As such, 5131 is the most common type (Hill with holm, Bi, low edaphic preluvisol and luvisol with *Vaccinium Calluna*), while the flora is characteristic for mixture forests.

BIBLIOGRAPHY

BĂLTEANU, D., CHENDEȘ, V., SIMA, M., ENCIU, P., 2010 - A country-wide spatial assessment of landslide susceptibility in Romania. Geomorphology, 124 (3-4): 102-112, Netherlands.

BLAGA, T., DINCA, L., PLEȘCA, I., 2019 - How can smart alder forests (Alnus glutinosa (L.) Gaertn.) from the Southern Carpathians be indentified and managed. Scientific papers series „Management, Economic Engineering in Agriculture and Rural Development", 19 (4): 29-35, Romania.

CÂNTAR, I.C., DINCĂ, L., CHISĂLIȚĂ, I., CRIȘAN, V., KACHOVA, V., 2019 - Identifying the oldest stands from the Southern Carpathians together with their main characteristics. Proceedings of the Multidisciplinary Conference on Sustainable development, Filodiritto International Proceedings, 186-193, Romania.

CIOBOTARU, A. M., ANDRONACHE, I., AHAMMER, H., RADULOVIC, M., PEPTENATU, D., PINTILII, R. D., ... FENSHOLT, R., 2019 - Application of Fractal and Gray-Level Co-Occurrence Matrix Indices to Assess the Forest Dynamics in the Curvature Carpathians—Romania. Sustainability, 11 (24): 6927, Switzerland.

CIONTU, C.I., DINCĂ, L., ENESCU, C.M., ONEȚ, A., ONEȚ, C., 2018 - Analyzing the importance of game species from Argeș County. Natural Resources and Sustainable Development, 8 (2): 138-147, Romania.

CIONTU, C.I., CHISĂLIȚĂ, I., DINCĂ, L., 2020 - Study concerning the evaluation of game and fish species from Caraș-Severin County. Annals of West University of Timișoara, ser. Biology, 23 (1): 21-28, Romania.

DINCĂ, L., MURARIU, G., ITICESCU, C., BUDEANU, M., MURARIU, A., 2019 - Norway spruce (Picea Abies (L.) Karst.) smart forests from Southern Carpathians. International Journal of Conservation Science, 10 (4): 781-790, Romania.

DINCĂ, L., BRATU, I., 2020 - Assessment of the distribution and characteristics of the oldest forests stand from the Romanian's Western Plain. Bulletin UASVM series Agriculture, 77 (2): 9-14, Romania.

DINCĂ, L., VECHIU, E., ONEȚ, A., 2020 - Can we identify manna ash (Fraxinus ornus L.) "smart forests" in Banatului Mountains? Natural Resources and Sustainable Development, 10 (1): 91-100, Romania.

DINCĂ, L., BREABĂN, I.G., 2020 - Smart hornbeam stands (Carpinus betulus L.) from the West Plain. Present Environment and Sustainable Development, 14 (2): 111-119, Romania.

GIBSON, L., LEE, T.M., KOH, L.P., BROOK, B.W., GARDNER, T.A., BARLOW, J., PERES, C.A., BRADSHAW, C.J.A., LAURANCE, W.F., LOVEJOY, T.E., SODHI, N.S., 2011 - Primary forests are irreplaceable for sustaining tropical biodiversity. Nature 478 (7369): 378–381, United States

GRECU, F., & COORDONATOR, 2020 - Dinamica albiei unor rauri din Carpatii si Subcarpatii de Curbura si relatia cu gestionarea durabila a spatiului. 10.13140/RG.2.2.10460.41604, Romania.

JACTEL, H., GRITTI, E. S., DRÖSSLER, L., FORRESTER, D. I., MASON, W. L., MORIN, X., ... CASTAGNEYROL, B., 2018 - Positive biodiversity–productivity relationships in forests: climate matters. Biology letters, 14 (4): 20170747, United Kingdom.

JONES, G.M., KEANE, J.J., GUTIÉRREZ, R.J., PEERY, M.Z., 2018 - Declining old-forest species as a legacy of large trees lost. Diversity and Distributions, 24 (3): 341-351, United Kingdom.

KEETON, W.S., WHITMAN, A.A., MCGEE, G.C. GOODALE, C.L., 2011 - Late-successional biomass development in northern hardwoodconifer forests of the northeastern United States. Forest Science, 57 (6): 489–505, United Kingdom.

MINEA, G., ILIESCU, M., DEDU, F., 2017 - Temporal rainfall properties at events scale in the Curvature Subcarpathians (Romania). Article submission, 115.

OGNJENOVIĆ, M., LEVANIČ, T., POTOČIĆ, N., UGARKOVIĆ, D., INDIR, K., SELETKOVIĆ, I., 2020 - Interrelations of various tree vitality indicators and their reaction to climatic conditions on a european beech (Fagus sylvatica L.) plot. Šumarski list, 144 (7-8): 351-365, Croatia.

SPRACKLEN, B.D., SPRACKLEN, D.V., 2019 - Identifying European old-growth forests using remote sensing: a study in the Ukrainian Carpathians. Forests, 10 (2): 127, Switzerland.

SPRACKLEN, B.D., SPRACKLEN, D.V., 2020 - Old-Growth forest disturbance in the Ukrainian carpathians. Forests, 11 (2): 151, Switzerland.

ŞOFLETEA, N., CURTU, L., 2007 - Dendrologie. Brasov, Universităţii" Transilvania" Publishing House; Romania

TIMIȘ-GÂNSAC, V., DINCĂ, L., CHEREGI, G., 2020 - Considerations concerning the oldest stands from Banatului Mountains, Romania. Sustainable Development Research, 2 (1): 64-71, Romania.

TIWARY, A., VILHAR, U., ZHIYANSKI, M., STOJANOVSK, I V., DINCA, L., 2020 - Management of nature-based goods and services provisioning from the urban common: a pan-European perspective. Urban Ecosystems, 23 (3): 645-657, United States

TUDOR, C., DINCĂ, L., 2019 - The main categories of non-wood forest products from Vrancea County. Research Journal of Agricultural Science, 51 (4): 211-217, Romania.

TUDOR, C., CONSTANDACHE, C., DINCĂ, L., 2021 - Implementing the hierarchy-analytic process within forest fruits from Mureș County, Romania. AGROFOR International Journal, 6 (1): 108-116, Romania.

VECHIU, E., DINCĂ, L., 2019. Forest fruits from Sibiu County. Research Journal of Agricultural Science, 51 (3): 163-168, Romania.

***AMENAJAMENTELE OCOALELOR SILVICE, 1999-2007: Voinesti (2005), Moreni (2005), Pucioasa (2005), Slanic (1999), Valeni (1999), Cislau (2004), Parscov (2006), Vintila Voda (2007), Dumitresti (2002), Vidra (2002). Romania