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Original scientific paper

STRUCTURAL CHARACTERISTICS OF MIXED BEECH STANDS IN THE AREA OF MAJDANPEK IN EASTERN SERBIA

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Abstract: This paper analyzes structural characteristics of mixed stands of beech in the territory of Eastern Serbia. The research was carried out on three experimental fields by applying classic stand inventory parameters and structural indices (Gini coefficient, Stand Density Index, Hart-Becking Index), with additional analysis of spatial structure of trees. A special contribution of the paper is the application of an innovative approach in the analysis of the spatial distribution of trees. Due to limited applicability of Hart-Becking Index in heterogeneous stands, Delaunay triangulation, which enables defining real neighboring trees was applied in the paper and thereby the stated limitation was overcome. The established differences in structural characteristics between the researched stands can be related to combined effect of habitat conditions and silvicultural treatments carried out in the past. Also, the obtained results indicate the importance of application of comprehensive and combined approach in defining the structural build of the stand, which can serve as a reliable tool in the process of defining silvicultural measures aimed at achieving the target stand structure.

Keywords: beech, stand structure, Gini coefficient, Stand Density Index, Hart-Becking Index.

STRUKTURNE KARAKTERISTIKE MEŠOVITIH SASTOJINA BUKVE NA PODRUČJU MAJDANPEKA U ISTOČNOJ SRBIJI

Abstract: U radu su analizirane strukturne karakteristike mešovitih sastojina bukve na području istočne Srbije. Istraživanje je sprovedeno na tri ogledna polja primenom klasičnih taksacionih pokazatelja i savremenih strukturnih indeksa (Gini koeficijent, indeks gustine sastojine, Hart-Becking-ov indeks), uz dodatnu analizu prostorne strukture stabala. Poseban doprinos rada predstavlja primena inovativnog pristupa u analizi prostornog rasporeda stabala. Zbog ograničene primenljivosti Hart-Becking-ovog indeksa u heterogenim sastojinama, u radu je primenjena Delaunay triangulacija, kojom je omogućeno definisanje realnih susednih stabala i time je prevaziđen navedeno ograničenje. Utvrđene razlike u strukturnim karakteristikama između ispitivanih sastojina mogu se dovesti u vezu sa kombinovanim delovanjem stanišnih uslova i uzgojnih tretmana sprovedenih u prošlosti.

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Takođe, dobijeni rezultati ukazuju na značaj primene sveobuhvatnog i kombinovanog pristupa u definisanju strukturne izgrađenosti sastojine, koji može poslužiti kao pouzdan alat u postupku definisanja uzgojnih mera u cilju postizanja ciljne strukture sastojine.

Keywords: bukva, struktura sastojine, Gini koeficijent, indeks gustine sastojine, Hart–Becking-ov indeks

1. INTRODUCTION

The range of distribution of beech (*Fagus spp.*) includes a wide belt of the northern hemisphere, whereby on European continent this species is absent only in the furthestmost northern and southern parts (Velkovski et al., 2023). Based on the morphological and ecological characteristics, ten different species of the genus *Fagus spp.* have been identified in the world (Jovanović, 2000). In addition to wide spectrum of environmental conditions in which genus *Fagus spp.* occurs on a global level, significant variations in habitat conditions at the local level were also manifested, which additionally makes the ecological and typological diversity of beech forests more complex. In Serbia, beech occurs on ten types of soil, from acidic silicate to basic carbonate substrates (Knežević, 2003), which results in great typological diversity of beech forests. An area located not far away from the object of the research, that is the area of Djerdap National Park where as many as sixteen types of pure and mixed beech stands were identified, with mixed stands having special importance, can serve as an example of this diversity (Medarević et al., 2001).

Considering the wide ecological gradient of the *Fagus spp.* species and its pronounced adaptability to different habitat conditions, it is expected for beech to occupy a dominant place in the forest growing stock of Serbia. With the increase in the importance of a certain tree species in the growing stock, the need for collection of as precise and quantified as possible information about the structure of the stands that form it also grows. The collected information contributes to better understanding of the system, while its larger scope improves readiness for decision making (MacKay, 1969).

Habitat and stand conditions affect the growth of trees with different intensity, whereby different growth courses of individual trees lead to their differentiation in terms of thickness, height, and other structural elements, by which a stand structure is formed. In forest management it includes the living horizontal and vertical arrangement of trees within the forest canopy, and it is subject to changes due to growth, disturbances and application of forest management measures (Medarević, 2006). At the same time, it can be seen as the result of a dynamic system of interaction between growth factors and habitat conditions, which continuously change and shape its structure (Stajić and Vučković, 2023). A more detailed analysis of the stand structure, in addition to the classic understanding of durability which includes the durability of production, yield and income (Medarević, 2006), represents a basis for establishment of ecological sustainability and application of forest management that is close to nature.

Research and analysis of forest structure enable better understanding of the past, current state and future development of forest ecosystems (Pretzsch et al., 2017;

Franklin et al., 2002). Therefore, detailed knowledge of the relationship between different plant species in forest and their environment, as well as the law of growth, regeneration and succession of forests is of exceptional importance. In addition, the results of research and their analysis provide a theoretical basis for scientifically founded defining of forest management measures (Hui et al., 2019). Certain traditional approaches in determining the stand structure were based on a limited number of variables, most often related to production of wood volume (Martać et al., 2022). On the other hand, considering the complexity of forest ecosystems, for a comprehensive and reliable overview of the stand structure, it is necessary to apply several different methods and indicators, which enable the analysis of both basic structural elements and mutual relationships between them (Becagli et al., 2013). Proceeding from the above, in this paper, in addition to the traditional analysis of basic elements of stand structure, the method of defining of stand structural form based on the homogeneity of the inventory that forms it is presented, as well as the spatial analysis of that inventory, on the basis of which the type of mixedness and density of the stand were determined, with the aim of a more complete understanding of structural build of the researched stands.

The study of the structure of beech stands in Serbia is of particular importance, considering their large representation in total forest growing stock, as well as pronounced diversity of habitat conditions in which they occur. The stand structure directly reflects processes of growth, competition, stability and regeneration and represents the basis for understanding of functioning and future development of these forest ecosystems. In this context, the application of several different methods and approaches in this paper enables more comprehensive perception of build of beech stands and it represents reliable basis for defining scientifically based forest management goals.

2. MATERIAL AND METHODS

2.1 The object of research

The research was carried out in Eastern Serbia, in the territory of the Forest Estate “Severni Kučaj” Kučevo (Figure 1). In order to study structural characteristics of stands, three beech stands were singled out during the field trip, within which three experimental fields (EF) of square shape were established.

Experimental field I (EF I) of the area of 0.5 ha ($x = 577713$; $y = 4923124$, WGS 84 / UTM zone 34N) is located at the altitude of 664 m, on the northwestern exposure. There is a tall mixed stand of beech of closed canopy in the experimental field.

Experimental field II (EF II) of the area of 0.25 ha ($x = 578101$; $y = 4923230$, WGS 84 / UTM zone 34N) is located at the altitude of 691 m, also on the northwestern exposure. There is a tall mixed stand of beech of closed canopy in the experimental field.

Experimental field III (EF III) of the area of 0.25 ha ($x = 578184$; $y = 4923686$, WGS 84 / UTM zone 34N) is located at the altitude of 710 m, on the southwestern exposure. There is a tall mixed stand of beech of dense canopy in the experimental field.

Considering the small distance between the experimental fields, climatic and pedological-geological characteristics are presented jointly for the whole researched area. The average mean annual temperature amounts to 11.6°C, while average annual precipitation amounts to 807 mm. Parent rock consists of limestone, and the soil is medium deep (16–40 cm).

On all experimental fields numeration of trees was carried out, whereby all the trees whose diameter at breast height was greater than 10.0 cm were included. The diameter at breast height, total height and length of a stem were measured for all the numerated trees, and their positioning in the field was carried out. The data collected were processed using software MS Excel and RStudio (R 4.5.1.).

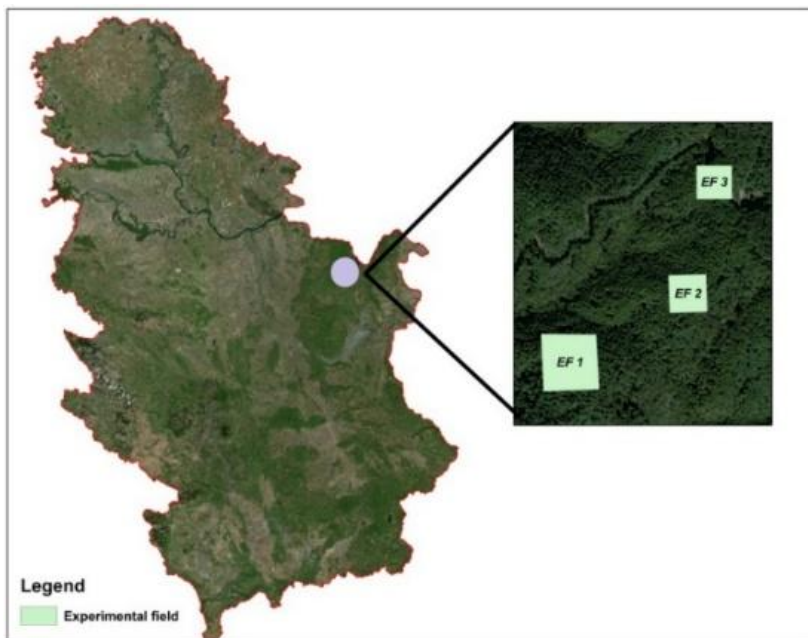


Figure 1. *The location of experimental fields*

2.2 Data processing

Stand inventory parameters were calculated using standard dendrometric methods (Banković and Pantić, 2006). The positioning of trees was carried out using theodolite. The measuring was started from vertex I (Figure 2), whereby the theodolite was placed so that the reading of “0” on the limb of the theodolite was always in the direction of the arrow on the sketch. All visible trees were covered from vertex I, and the same procedure was applied also from vertices II, III and IV. After the collection of data on positions of the trees in the field, their calculation was carried out; the example of calculation for the field of 0.25 ha (50x50 m) is presented in Table 1.

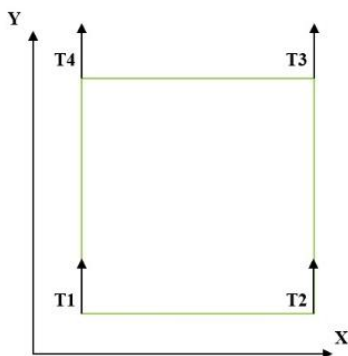


Figure 2. Experimental field 50x50 (m)

Table 1. Determining the position of trees on the experimental field

A	B	C	D	E	F	G
Vertex	Angle (gradians)	Angle (degrees) (B*0.9)	Angle (radians) (C*(3.14/180))	Distance (meters)	Coordinate X (meters) (E*SIN(D))	Coordinate Y (meters) (E*COS(D))
1		(B*0.9)	(C*(3.14/180))		(E*SIN(D))	(E*COS(D))
2		(B*0.9)	(C*(3.14/180))		(E*SIN(D))+50	(E*COS(D))
3		(B*0.9)	(C*(3.14/180))		(E*SIN(D))+50	(E*COS(D))+50
4		(B*0.9)	(C*(3.14/180))		(E*SIN(D))	(E*COS(D))+50

* in the column “Angle” enter the measured angle from the vertex toward the tree, in the column “Distance” enter the distance measured from the vertex toward the tree

The homogeneity and structural build of the researched stands was examined using the Gini coefficient, stand density index (SDI according to Reineke), relative distance between trees (the Hart-Becking Index), average distance between neighboring trees (Delaunay triangulation), minimal average distance between trees, spatial distribution of trees at the level of species (the Winkelmass Index).

The homogeneity of tree volume in the stand was evaluated using the Gini coefficient, whereby the volumes of individual trees were ranked in ascending order in accordance with the procedure of its application (Genève, 2019).

$$GC(x_1 \dots x_n) = \frac{2 \sum_{i=1}^n i x_i}{n \sum_{i=1}^n i x_i} - 1 - \frac{1}{n}$$

i – the reference rank number for the associated tree volume;

x_i – tree volume belonging to the reference rank;

n – total number of ranks.

Stocking percent of the stand was expressed through the index according to Reineke (SDI) (Reineke, 1933) which was primarily developed as a measure for describing even-aged structural forms of a stand, whereby with certain adaptation it is also used for uneven-aged stands (Stage, 1986; Long and Daniel, 1990; Shaw, 2000; Woodall et al., 2005; Popović, 2023).

For even-aged structural form it is determined using the following formula (Long, 1985):

$$SDI = N * \left(\frac{dg}{25}\right)^{1,6}$$

For uneven-aged structural form it is determined using the following formula (Shaw, 2000):

$$SDI = \sum_{i=1}^n \left(\frac{d_i}{25}\right)^b$$

N – total number of trees per hectare;

dg – mean diameter of the stand per basal area in (cm);

d_i – diameter of reference (observed) tree in (cm).

Relative distance between trees (RS), i.e. *Hart-Becking Index* was obtained using the following formula (Stajić and Vučković, 2023):

$$RS = \frac{\sqrt{10000/N}}{H_{dom}} * 100 (\%)$$

N – total number of trees per hectare;

H_{dom} – average height of 20% of the tallest trees.

The Hart–Becking Index of relative distance between the trees was applied for evaluation of stand density, whereby number of trees per hectare and upper stand height were used as input parameters. This index was primarily developed for even-aged stands, where a relatively uniform distribution of trees in space is assumed (Gadow, 2003). It is difficult to apply Hart – Becking Index in more heterogeneous stand forms due to the fact that more heterogeneous stand forms such as uneven-aged and selection stands have a significantly more heterogeneous arrangement of trees in space, in terms of the distance between neighboring trees, so the upper part of the formula representing the average distance between trees per hectare ($\sqrt{10000/N}$) is not applicable in uneven-aged stands.

To adapt the index for uneven-aged stands, Delaunay triangulation of tree positions based on the In-Circle predicate (Guibas and Stolfi, 1985) was carried out in this paper (Figure 3), thus enabling the definition of real neighboring trees and calculation of “real” distance between them.

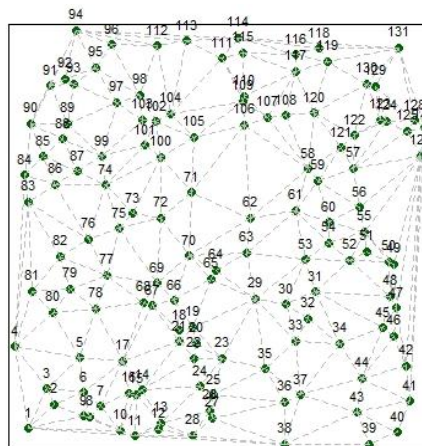


Figure 3. Delaunay triangulation EF I

Minimum average distance between trees was obtained based on determining the distance of 4 closest neighboring trees, whereby the sum of all averages was divided by the number of trees on the experimental field.

The information based on mutual relations of trees, such as single-tree and group arrangement of trees, the mixture that these trees make and differentiation of trees according to dimensions, can be used for providing a comprehensive description of spatial structure of the stand (Gadow and Hui, 2002). Therefore, spatial distribution of trees was analyzed in this research.

Defining the type of spatial distribution of trees at the level of tree species (single-tree, group, sporadic) was determined based on the *Winkelmass Index*. The Winkelmass index describes regularity or irregularity of spatial distribution of trees closest to the reference (observed) tree (Gadow and Hui, 2002).

Winkelmass Index was obtained using the following formulas (Gadow and Hui, 2002):

$$W = \frac{1}{N} \sum_{i=1}^N W_i$$

$$W_i = \frac{1}{4} \sum_{j=1}^4 v_j$$

W – average value of *Winkelmass Index*;

W_i – *Winkelmass Index* of the i – *th* reference tree;

N – number of reference trees;

v_j – binary variable.

3. RESULTS AND DISCUSSION

Since the analysis was focused on the structure of the researched stands, numerical indicators (Tables 2-4) relate to the level of stand, i.e. they do not relate to tree species.

Table 2. Numerical indicators for *EF I*

N/ha	G/ha	dg (cm)	dg max (cm)	hg (m)	hg max (m)	h dom 20% (m)	Gini coefficient	V m ³ /ha
262	38.7	43.4	59.4	29.5	32.3	33.1	0.393	572.8
Stand Density Index SDI according to Reineke			Relative distance between the trees RS, the Hart-Becking Index (%)				Average minimum distance between trees (m)	
305.41			23.11				5.53	

*The Hart-Becking Index was determined by conducting Delaunay triangulation, whereby the average distance was 7.65 m

Table 3. Numerical indicators for EF II

N/ha	G/ha	dg (cm)	dg max (cm)	hg (m)	hg max (m)	h dom 20% (m)	Gini coefficient	V m ³ /ha
496	42.2	33.0	44.4	25.2	28.4	30.3	0.319	618.0
Stand Density Index SDI according to Reineke			Relative distance between the trees RS, the Hart-Becking Index (%)				Average minimum distance between trees (m)	
774.47			14.82				4.24	

Table 4. Numerical indicators for EF III

N/ha	G/ha	dg (cm)	dg max (cm)	hg (m)	hg max (m)	h dom 20% (m)	Gini coefficient	V m ³ /ha
692	47.4	29.8	39.8	25.6	27.7	28.1	0.317	607.8
Stand Density Index SDI according to Reineke			Relative distance between the trees RS, the Hart-Becking Index (%)				Average minimum distance between trees (m)	
916.62			13.53				3.44	

On EF I the smallest number of trees was recorded (262 trees/ha). The total volume amounts to 572.8 m³/ha. On this EF the highest values of medium and dominant stand trees were recorded per basal area (dg = 43.4 cm; hg = 29.5 m; dg_{max} = 59.4 cm; hg_{max} = 32.3 m). The value of the Gini coefficient (0.393) shows a more pronounced structural unevenness i.e. greater differentiation of trees by dimensions. The value of SDI (305.41) and values of the Hart-Becking Index (RS = 23.11) confirm lower stand density, while greater minimum average distance between trees (5.53 m) indicates weaker mutual competition compared to other two fields.

On EF II a larger number of trees is observed (496 trees/ha) with a decrease in the average size of the trees (dg = 33.0 cm; hg = 25.2 m; dg_{max} = 44.4 cm; hg_{max} = 28.4 m). The volume reaches maximum value (618.0 m³/ha) compared to other two fields. The Gini coefficient (0.319) is lower than for the field I, which indicates greater structural homogeneity. The value of SDI (774.47) and presence of the Hart-Becking Index (RS = 14.82) confirm higher stand density and more pronounced competition. Minimum average distance between trees (4.24 m) confirms the results obtained.

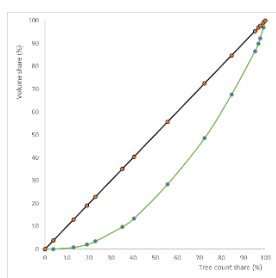
EF III is characterized by the highest density (692 trees/ha) and the smallest average dimensions of trees (dg = 29.8 cm; hg = 25.6 m; dg_{max} = 39.8 cm; hg_{max} = 27.7 m). Although the basal area is (47.4 m²/ha), volume (607.8 m³/ha) is somewhat lower than on the field II. The lowest Gini coefficient (0.317) indicates even more uniform structure in terms of dimensions. The highest value of SDI (916.62) as well as minimum average distance between trees (3.44 m) indicate the highest density and confirm a high degree of competition.

The values of Gini coefficient for even-aged structural forms of a stand range from 0.15 to 0.30, while for uneven-aged stands it amounts to 0.37 – 0.54. (Lee et al., 1999; Bravo-Oviedo et al., 2018; Popović et al., 2021). The obtained value of Gini coefficient on EF I corresponds to a given interval for uneven-aged stands, while the values obtained on the other two experimental fields approximate the upper limit for even-aged structural form.

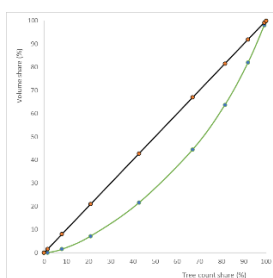
Considering the values of SDI on the one hand and numerical indicators on the other hand, it is evident that a significantly better balance has been established

between the use of space for the growth of trees and other stand inventory parameters on EF I, compared to the stands of EF II and III.

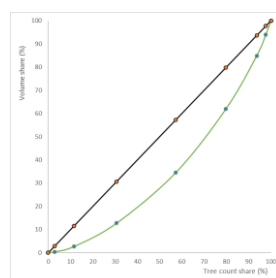
The cumulative ratio of the percentage of the number of trees and the percentage of the volume that the trees make up in the stand, is presented graphically in the form of a Lorenz curve (Graphs 1-3). Deviation of the volume homogeneity of inventory that builds the stand is possible to observe if the differences in volume per certain diameter degrees are presented graphically in the form of Lorenz curve. If the stand is more heterogeneous in terms of the volume of trees that make it up, Lorenz curve will deviate more from the reference line that represents ideal homogeneity in the volume of all trees in the stand (Kramer, 1988). Based on the presented graphs (1 – 3) heterogeneity of the inventory that makes up the volume of the stand of EF I can be clearly observed compared to more homogeneous inventory on the other two experimental fields.



Graph 1. EF I

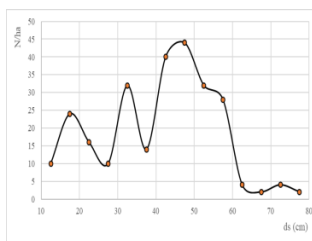


Graph 2. EF II

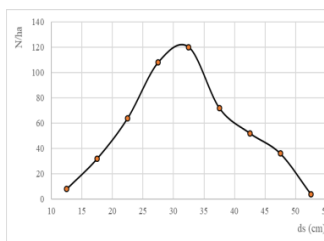


Graph 3. EF III

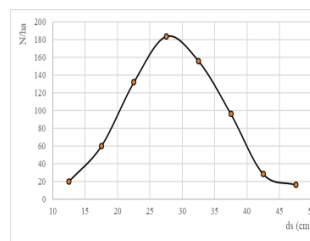
By observing diameter structure (Graphs 4-6) a clear difference in distribution of number of trees by diameter degrees can be observed between EF I (Graph 4) and EF II and III (Graphs 5 and 6). Diameter variation width for EF I, EF II and EF III amounts to 67.6 cm, 39.5 cm and 36.4 cm, respectively. More pronounced tree diameter variation width on EF I compared to the other two fields confirms more heterogeneous structure on EF I.



Graph 4. EF I



Graph 5. EF II



Graph 6. EF III

The values of W Index (Tables 5-7) differ depending on spatial distribution of trees. In accordance with the 72° standard angle required to yield an average of 0.5 for random distributions, values lower than 0.475 are considered for the regular arrangement of trees in the space, while those higher than 0.517 indicate a clumped arrangement (Gadow and Hui, 2002).

Single-tree and group tree arrangement was noted in all experimental fields depending on the tree species (Figures 4-6), whereby only on the EF II the dominant species (beech) is represented in group tree arrangement, while in other two fields beech is represented in single-tree arrangement.

Table 5. *The Winkelmass Index for EF I*

Tree species	W Index	Arrangement	Share in volume (%)
Beech	0.491	Single-tree	85.54
Sycamore maple	0.594	Group	9.96
Norway maple	0.607	Group	4.49

Table 6. *Winkelmass Index for EF II*

Tree species	W Index	Arrangement	Share in volume (%)
Beech	0.520	Group	95.54
Sycamore maple	0.536	Group	3.6
European hornbeam	/	Sporadic	0.85

Table 7. *Winkelmass Index for EF III*

Tree species	W Index	Arrangement	Share in volume (%)
Beech	0.512	Single-tree	85.35
Sycamore maple	0.554	Group	10.39
Norway maple	/	Sporadic	2.21
Large-leaved linden	/	Sporadic	1.16
Scots elm	/	Sporadic	0.90

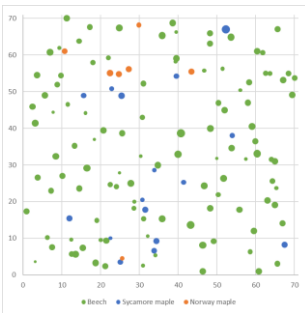


Figure 4.
Tree positions in EF I

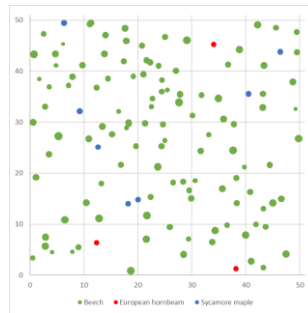


Figure 5.
Tree positions in EF II

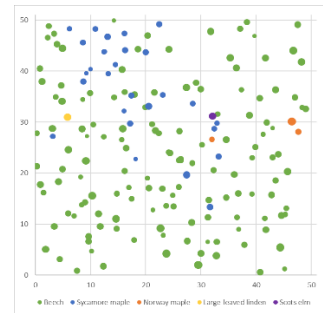


Figure 6.
Tree positions in EF III

4. CONCLUSION

The results of the research can be related to the joint influence of habitat factors and applied forest management treatments in the past, which is reflected in the build, density, degree of tree differentiation and spatial distribution of trees in the stand. The analysis of three experimental fields showed clear differences in structural characteristics, whereby EF I stands out for its more pronounced structural heterogeneity, while experimental fields II and III are characterized by higher degree of homogeneity and more pronounced competitiveness due to increased density.

An approach based on the simultaneous analysis of several interrelated elements, enables a more reliable and comprehensive overview of stand build, because individual indicators alone cannot always fully describe the complexity of forest ecosystems. The results indicate that structural heterogeneity cannot be observed exclusively through one aspect, but it is necessary to analyze simultaneously several structural components, including their mutual relations.

Additional contribution of the presented results is reflected in the analysis of the stand spatial structure, which enables more detailed perception of spatial distribution of trees and their mutual relations. By applying the Winkelmass Index, the type of spatial distribution of trees has been determined, whereby the presence of single-tree and group arrangement was recorded, with clear differences between experimental fields. It is particularly important to point out that the way of overcoming limitations of classical methods for determining the relative distance between trees in the process of defining spatial structure is presented in this paper. Given that the Hart–Becking Index in its basic form is based on the assumption of even distribution of trees, its application in heterogeneous stands is limited. By applying Delaunay triangulation, defining real neighboring trees and calculation of real mutual distances is enabled, which gave a more realistic picture of stand density and spatial arrangement of trees within it. In this way, one of the key limitations in the analysis of stand spatial structure which relates to the reliable defining of mutual distance between trees in heterogeneous stands has been overcome, which represents significant methodological contribution.

The results of the research confirm the significance of application of integral approach in the analysis of stand structure, which implies simultaneous consideration of several structural elements and their spatial relationships, which ensures a more reliable and comprehensive overview of forest stand structure. The obtained results represent a reliable tool in the process of defining silvicultural measures depending on the previously defined target stand structure, because they enable a clear overview of existing structural condition and relationships between trees within the stand.

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STRUCTURAL CHARACTERISTICS OF MIXED BEECH STANDS IN THE AREA OF MAJDANPEK IN EASTERN SERBIA

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Summary

This paper analyzes structural characteristics of mixed stands of beech in the territory of Eastern Serbia with the aim of more complete understanding of them through application of several complementary methods. The research was carried out on three experimental fields, whereby, in addition to classical stand inventory parameters, modern structural indices which enable more detailed analysis of tree differentiation, density and mutual relationships within the stand are applied, too. Special attention was paid to the analysis of spatial structure, where the application of Delaunay triangulation improved the determination of the mutual distances of trees, which enabled a more realistic observation of the structure in heterogeneous stands.

The obtained results indicate pronounced differences in structural characteristics between the examined stands, which can be related to the combined action of habitat conditions and silvicultural treatments carried out in the past. At the same time, the results confirm that the stand structure cannot be reliably evaluated based on individual indicators

but requires the application of an integrated approach that comprises several structural elements and their spatial relationships.

As such, the applied approach enables more reliable observation of the existing structural condition of the stand and can serve as a significant basis for defining silvicultural measures in accordance with predefined target structure and long-term forest management goals.

STRUKTURNE KARAKTERISTIKE MEŠOVITIH SASTOJINA BUKVE NA PODRUČJU MAJDANPEKA U ISTOČNOJ SRBIJI

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Rezime

U radu su analizirane strukturne karakteristike mešovityh sastojina bukve na području istočne Srbije sa ciljem njihovog potpunijeg sagledavanja kroz primenu više komplementarnih metoda. Istraživanje je sprovedeno na tri ogledna polja, pri čemu su, pored klasičnih taksacionih pokazatelja, primenjeni i savremeni strukturni indeksi koji omogućavaju detaljniju analizu diferencijacije stabala, gustine i međusobnih odnosa unutar sastojine. Posebna pažnja posvećena je analizi prostorne strukture, gde je primenom Delaunay triangulacije unapređeno određivanje međusobnih rastojanja stabala, čime je omogućeno realnije sagledavanje strukture u heterogenim sastojinama.

Dobijeni rezultati ukazuju na izražene razlike u strukturnim karakteristikama između ispitivanih sastojina, koje se mogu dovesti u vezu sa kombinovanim delovanjem stanišnih uslova i uzgojnih tretmana sprovedenih u prošlosti. Istovremeno, rezultati potvrđuju da se struktura sastojine ne može pouzdano oceniti na osnovu pojedinačnih pokazatelja, već zahteva primenu integrisanog pristupa koji obuhvata više strukturnih elemenata i njihove prostorne odnose.

Kao takav, primenjeni pristup omogućava pouzdanije sagledavanje postojećeg strukturnog stanja sastojine i može poslužiti kao značajna osnova za definisanje uzgojnih mera u skladu sa unapred definisanom ciljnom strukturom i dugoročnim ciljevima gazdovanja.