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AESTHETIC VALUE OF SMEDEREVO FORTRESS EXPRESSED THROUGHOUT PARAMETERS OF BIOECOLOGICAL ANALYSES

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SUMMARY: Smederevo fortress is a fortified medieval town, an area of 10,5 ha. As a city park, belongs to a category of green space of general purpose. Bioecological analysis had the aim to highlight the important parameters for assessing the aesthetic values of the area. Cluster analysis was applied to determine the relatively homogenous groups of tree species. The results showed that the current state of greenery composition is not at a high level. Further improvement of the space should be directed towards highlighting a monumentality of vegetation, in order to justify the space and its history.

Key words: *Smederevo fortress, aesthetic values of the greenery, bioecological parametres.*

INTRODUCTION

Green spaces (gardens, parks and other landscape formations) are important elements of each city. As a part of the city image and its surroundings, they expand ecological diversity and essentially make cities and urban areas more suitable for living. The urban forests are green areas, made up of trees and other vegetation within the urban environment (Peschardt et al., 2012; McPherson et al., 2005). They have an important place in the biodiversity of the cities, as a segment of urban greenery, but their vegetation is affected by a number of anthropogenic stressors (LaPaix and Freedman, 2010). With the aim of increasing the functionality of urban greenery, it is necessary to assess their state, which is an initial step towards the rehabilitation and improvement of plant health and visual appearances (Stavretović et al., 2010). Urban green spaces, and urban forests, as the areas of multiple sociological functions (Ranković and Keča, 2007), are directly used for active or passive recreation of the population, and their presence, indirectly affect the

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quality of the urban environment awareness (Hadžidervišagić, 2011). In the city, plants and "green space" are considered to be psychologically and socially, as well as environmentally beneficial. They give people a "contact with nature" considered both calming and restorative; they encourage people to spend time in public spaces, thus enhancing community safety, and they produce various well-known positive environmental effects (Despard, 2012). Many existing urban green spaces in the city of Smederevo slowly losing its previous sociological value. Smederevo fortress, as the central city park as well as cultural-historical resource of great value, is one of the few green areas in the city, which is still active in this field. However, the degradation of its landscape composition, as well as aesthetic and decorative values of dendroflora, will significantly reduce a sociological value of the space.

Smederevo fortress lies on the right bank of the river Danube The Danube region is on of the most interesting regions in Europe in geographical and historical viewpoint (Kovács, 2011). The numerous sites of Roman and medieval periods on its shores are just witnesses of this state. The largest Serbian medieval town, Smederevo, was built in the third decade of the 15th century. With a triangular shape, 25 towers, walls with height over 10 m and width around 4.5 meters, the fortress of Smederevo covers an area of nearly 10,5 hectares. The fortress is surrounded by water on two sides while the third side is faced towards land. It is constituted from the Big and the Small Town. The entire town was built of stones of various composure (Stojsavljević et al., 2011).

A Special importance Smederevo got early in the fifteenth century, at the time of despot Đurađ Branković, when the city became the last capital of the Serbian medieval time and the seat of ecclesiastical and economic life. At that time the importance of Smederevo exceeded local and regional dimension and Smederevo became the center of the crossroads of civilizations, the center of overlapping influences of the East and the West (Petronijević, 2006).

MATERIAL AND METHODS

The results obtained in this study were analyzed by using several methods. First of all concerned research had the approach with qualitative type and included the study of accessible literature sources, namely the available documentation, which served as a source of general information about the historical development of the park.

In a further phase of this research bioecological analysis of vegetation was applied, actually bioecological analysis of dendrofond of the researched area of Smederevo fortress. As an indicators of biological and ecological values according to Anastasijević (2000) the following characteristics of trees species were measured: tree height (m), tree height to first branch (cm), trunk diameter (cm) and width of a canopy (cm). Height of trees was measured with Vertex laser altimeter. Standard diameter was used for determination of trunk diameter at a height of 1,30 m. At the end with the aim of overall estimation of dendrofond of Smederevo fortress, the values of vitality and decorativeness were given from 1-5 (1 as the lowest and 5 as the best grade).

In order to organize obtained data, their interpretation and the relevant evaluation, data were analyzed by using the statistical software Statistica10 (StatSoft , OK, USA).

RESULTS AND DISCUSSION

Within 27 plant species and among 27 genotypes, located in Smederevo fortress there are 123 individual adult trees. Considering its surface spreadness, the composition of space and vegetation is very monotonous and modesty. Within total number of adult trees, deciduous have a dominance, while there are only two individuals of coniferous species *Juglans regia* L. and *Picea pungens* Engelm. The most numerous individuals are: *Platanus acerifolia* (Ait.) Wild. witht 32 individuals (26%), *Populus nigra* L.*'Italica'*/ Mnch./Du Roi with 20 individuals (16%), then *Fraxinus excelsior* L. with 11 individuals (9%), followed by *Acer saccharinum* L. with 10 individuals (8%), *Fraxinus angustifolia* Vahl with 7 individuals (6%), *Morus alba* L. *'Pendula'*/Dipp. with 4 individuals (4%) and *Celtis occidentalis* L. also with 4 individuals (4%). Other plant species are represented mostly in identical percentage rating with less than 4%.

In the area of Smederevo fortress there are eight plant species that are present only with one individual. Some of those species are: *Morus alba* L., *Betula pendula* Ehrh., *Broussonetia papyrifera* L'Her ex Vent., *Picea pungens* Engelm, *Acer negundo* L., *Tilia parvifolia* Ehrh, *Junglas regia* L., *Populus tremula* L. It is a fact that their participation in total vegetation composition can't make a significant contribution to the overall value of aesthetic quality of the space.

Vegetation composition of the entire area is dominantly created with tree lined planting, also partly in groups, and what is more, there are a lot of solitary species spread through whole area. This makes whole space composition very chaotic and without clear idea. Table 1 shows the studied parameters of the bioecological analysis. The species emphasized by the highest mean values for height are: *Populus x euroamericana* (Dode) Guinier (22,50 m), *Populus alba* L.(21,50m), *Quercus robur* L.(21m), *Populus nigra* L.*'Italica'*/ Mnch./Du Roi (19,35m), *Platanus occidentalis* L. (18,50m). Plant with the lowest height is *Picea pungens* Engelm. with mean value of 2 m. Comparing to other plant species *Picea pungens* Engelm. has the narrowest canopy as well (1 m), which is in accordance to it hight value. None of the present plant species has not yet reached its full height, even the existing environmental conditions are positive for them. This can be explained by not reaching their full age, also by negative impact that comes from a poor maintaining. Considering the fact that individuals of the following plant species *Platanus occidentalis* L., *Catalpa bignonioides* Walt., *Acer pseudoplatanus* L., *Acer platanoides* L., *Quercus robur* L., *Populus alba* L., *Populus x euroamericana* (Dode) Guinier, *Fraxinus ornus* L., are found in the space in a small groups (2-3 individuals), they can be consider almost as a solitary species. This is probably a reason why they were highlighted as a species with the high mean values of trunk height (3,50m, 3,10m, 4m, 4m, 4,75m, 3m), *Populus x euroamericana* (Dode) Guinier and *Fraxinus ornus* L. are out of this group considering the values (2,25m, 2,75m). In contrast to them are folowing plant species: *Populus nigra* L.*'Italica'*/ Mnch./Du Roi (1,29m), *Morus alba* L. *'Pendula'*/Dipp. (1,56m) and Celtis occidentalis L. (1,97m). This low value of *Populus nigra* L.*'Italica'*/ Mnch./Du Roi can be explained by its age and with the growth of adventitious branches on the tree.

The widest canopy (which again may be explained by their position in small groups) have the following plant species: *Populus alba* L. (19,50m), *Quercus robur* L. (18m), *Morus alba* L. (17m), *Populus x euroamericana* (Dode) Guinier (16,50m), while the species with the lowest canopy are: *Picea pungens* Engelm. (1 m), *Morus alba* L.

’Pendula’/Dipp. (2,46m), *Juglans regia* L. (2,50m) and *Populus nigra* L.*’Italica’*/ Mnch./ Du Roi (4,39m). Since this species do not reach a big width, it can be concluded that they were adapted to existing environmental conditions.

Table 1. Pattern of testified parameters of bioecological analyses of dendrofond of Smederevo fortress

Tree species	N	Height (cm)			Trunk height (cm)			Trunk Diameter (cm)			Width of the canopy (cm)			Value of the vitality (VIT)			Value of the decorativeness (DEK)		
		Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
Morus alba ‘Pendula’	5	2.30	0.27	11.91	1.56	0.13	8.60	22.20	2.59	11.66	2.46	0.09	3.64	2.80	0.45	15.97	3.00	0.00	0.00
Platanus occidentalis	2	18.50	3.54	19.11	3.50	2.12	60.61	56.50	23.33	41.30	15.50	6.36	41.06	2.50	2.12	84.85	3.50	2.12	60.61
Fraxinus angustifoila	7	15.57	3.60	23.11	2.29	0.39	17.21	47.71	6.10	12.79	12.93	4.15	32.08	3.29	0.49	14.85	3.29	0.49	14.85
Catalpa bignonioides	3	13.00	3.50	26.92	3.10	0.53	17.07	29.33	4.04	13.78	8.03	2.52	30.20	2.33	0.58	24.74	3.00	0.00	0.00
Celtis occidentalis	5	10.25	1.67	16.25	1.93	1.11	57.38	42.17	10.94	25.95	8.83	2.58	29.23	3.00	0.00	0.00	3.17	0.41	12.89
Populus nigra ‘Italica’	20	19.35	1.57	8.13	1.29	0.75	58.65	46.20	9.13	19.77	4.39	3.24	73.89	2.40	0.50	20.94	2.95	0.39	13.36
Acer pseudoplatanus	2	13.00	0.00	0.00	4.00	0.00	0.00	39.00	4.24	10.88	11.50	2.12	18.45	2.50	0.70	1.41	3.00	28.28	47.14
Acer platanoides	3	12.50	0.86	6.93	4.00	0.00	0.00	36.67	12.01	32.77	10.67	2.08	19.51	3.00	0.00	0.00	3.33	0.58	17.32
Fraxinus lanceolata	4	14.13	1.75	12.39	3.27	0.74	22.49	31.25	9.47	30.29	8.50	1.73	20.38	2.50	0.58	23.09	2.75	0.56	18.18
Fraxinus excelsior	11	14.77	1.13	7.62	3.14	0.46	14.70	33.82	6.66	19.70	9.00	1.95	21.66	2.27	0.47	20.55	2.64	0.50	19.14
Platanus acerifolia	32	17.89	3.39	18.94	2.66	1.14	42.80	44.84	17.28	38.54	11.94	2.22	18.60	2.87	0.42	14.89	2.90	0.54	18.56
Quercus robur	2	21.00	1.41	6.73	4.75	2.47	52.10	52.50	10.61	20.20	18.00	9.90	55.00	3.50	0.71	20.20	3.50	0.71	20.20
Populus alba	2	21.50	2.12	9.87	3.00	1.41	47.14	80.00	28.28	35.36	19.50	0.70	3.63	4.00	0.00	0.00	5.00	0.00	0.00
Acer saccharinum	10	16.20	1.23	7.59	2.20	0.95	43.12	54.50	12.79	23.45	9.75	1.99	20.41	2.60	0.70	26.89	2.70	0.82	30.49
Populus x euroamericana	2	22.50	0.70	3.14	2.25	0.35	15.71	50.00	7.07	14.14	16.50	2.12	12.86	2.00	0.00	0.00	3.00	0.00	0.00
Fraxinus ornus	2	15.00	4.24	28.28	2.75	0.35	12.86	42.50	24.75	58.23	12.00	4.24	35.36	2.50	0.71	28.28	2.50	0.71	28.28
Morus alba	1	18.00	_	_	2.50	_	_	50.00	_	_	17.00	_	_	3.00	_	_	4.00	_	_
Betula pendula	1	14.00	_	_	1.50	_	_	30.00	_	_	9.00	_	_	4.00	_	_	4.00	_	_
Broussonetia papyrifera	1	13.00	_	_	2.00	_	_	49.00	_	_	13.00	_	_	4.00	_	_	5.00	_	_
Picea pungens	1	2.00	_	_	0.80	_	_	5.00	_	_	1.00	_	_	2.00	_	_	2.00	_	_
Acer negundo	1	13.00	_	_	1.50	_	_	40.00	_	_	12.00	_	_	2.00	_	_	2.00	_	_
Salyx babylonica	1	13.50	_	_	2.50	_	_	50.00	_	_	12.00	_	_	4.00	_	_	4.00	_	_
Salyx alba ‘pendula’	1	13.00	_	_	2.00	_	_	60.00	_	_	12.00	_	_	3.00	_	_	3.00	_	_
Junglas regia	1	16.00	_	_	3.00	_	_	50.00	_	_	14.00	_	_	3.00	_	_	3.00	_	_
Populus tremula	1	4.00	_	_	1.50	_	_	10.00	_	_	2.50	_	_	5.00	_	_	3.00	_	_
Tilia parvifolia	1	15.00	_	_	2.25	_	_	25.00	_	_	10.00	_	_	3.00	_	_	3.00	_	_
Acer obtusatum	1	13.00	_	_	5.00	_	_	30.00	_	_	13.00	_	_	3.00	_	_	4.00	_	_

Over 50% of total analyzed existing plant species, in Smederevo fortress, have received a low grade of vitality and decorativeness (up to 3). As the most prominent vital and decorative species were found: *Populus alba* L. (VIT= 4, DEK=5), *Salyx babilonica* L. (VIT=4, DEK=4), *Betula pendula* Ehrh. (VIT=4, DEK=4), *Quercus robur* L. (VIT= 3,5, DEK=3,5). The lowest grades for the vitality received *Populus x euroamericana* (Dode) Guinier (2), *Picea pungens* Engelm. (2), *Acer negundo* L. (2), while the lowest grade for the value of decorativeness was given to *Fraxinus ornus* L. (2,50), *Picea pungens* Engelm. (2) and *Acer negundo* L. (2). Such low values can be explained with the species unadaptible to the natural environmental conditions.

Cluster analysis grouped the researched species into subclusters (Figure 1). Hierarchical classification of 25 tree species was divided into 10 groups of subclusters. Groups are composed of the following species:

1) Populus alba L.
2) Celtis occidentalis L.
3) Salyx babilonica L., Acer saccharinum L., Populus nigra L. 'Italica'/ Mnch./Du Roi
4) Acer obtusatum Wldst. et Kit, Tilia parvifolia L., Betula pendula Ehrh.
5) Fraxinus lanceolata Borkh., Catalpa bignonioides Walt.
6) Populus x euroamericana (Dode) Guinier, Quercus robur L.
7) Morus alba L.
8) Fraxinus excelsior L., Platanus acerifolia (Ait.) Willd., Fraxinus ornus L., Acer negundo L., Acer platanoides L., Acer pseudoplatanus L., Broussonetia papyfera L'Her. ex Vent., Juglans regia L., Fraxinus angustifolia Vahl
9) Platanus occidentalis L.
10) Picea pungens Engelm., Populus tremula L., Morus alba L. 'Pendula'/ Dipp.

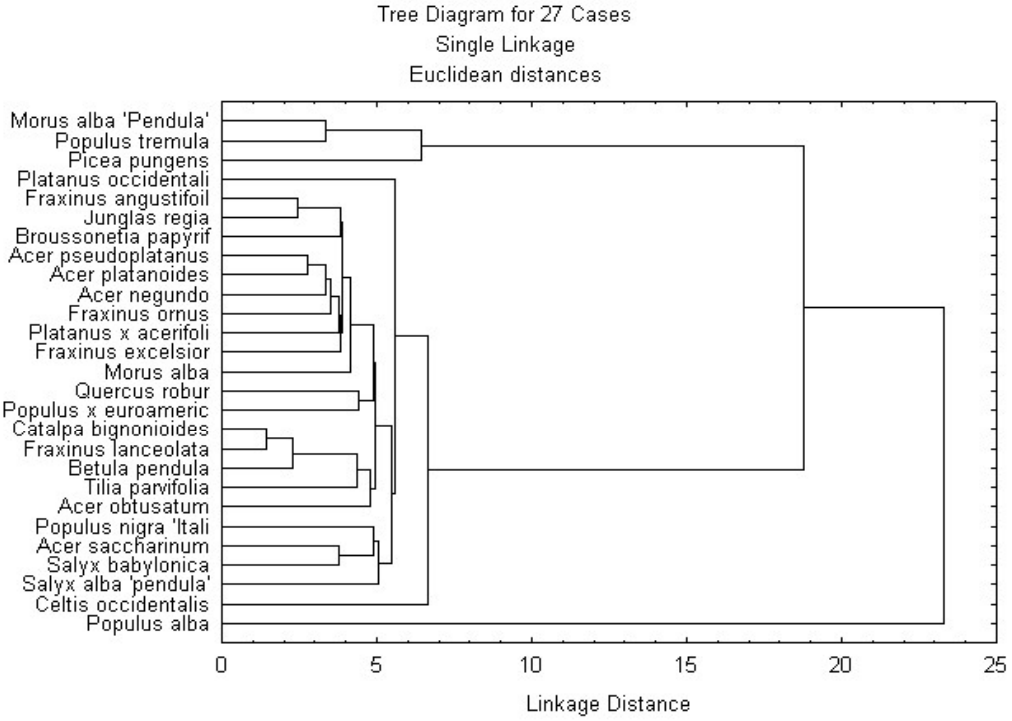

Fig. 1. Cluster analysis of 27 adult tree species

White poplar (*Populus alba* L.) is a very effective tree for monumental compositions, for big parks and park forests on alluvial terrain. It can be planted in groups, small forests mixed with red oak, black poplar, black alder or other types with darker foliage (Vukićević, 2006). What is more white poplar is suitable as a soliter because of its broad and bright canopy (Ocokoljić and Ninić-Todorović, 2003). In the area of Smederevo fortress, trees of this kind are extremely well adapted, and the reason for that are certainly appropriate and natural conditions. White poplar has good grades for all parameters of bioecological analysis and as such is highlighted in a separate subcluster.

In the second group of sublusters is *Celtis occidentalis* L. as a tree species with very high value of trunk diameter (42,17) and very low value of trunk height (1,93).

The third group consists of Weeping Willow (*Salyx babilonica* L.), Silverleaf Maple (*Acer saccharinum* L.) and Lombardy Black Poplar (*Populus nigra* L.*'Italica'*/Mnch./ Du Roi); the species that were emphasized to its values of vitality and decorativness. Not so far in the past, the individuals of Weeping Willow were much more numerous in Smederevo fortress, and with its decorativness had a lot of influence to the aesthetic value of the space. Since, they were directly exposed to gust of wind, branches were broken and many individuals had to be removed. Considering a Black Poplar species, due to their strong root system, this type is very suitable for binding a river banks, also very some of its clones showed a good results (*Populus x euramericana* Dode (Guinier) and *Populus deltoides W.Bartram* ex Humphry Marshall) (Blagojević et al., 2011). This data can be used in order to avoid a formation of monoculture in the field. So, besides individuals of Lombardy Black Poplar trees (*Populus nigra* L.*'Italica'*/Mnch./Du Roi), as a variety of Black Poplar, also in the vegetative composition it can be introduced some of its clones, in order to avoid the danger of monoculture.

Bosnian maple (*Acer obtusatum* Wldst. et Kit), Small-leaved Lime (*Tilia parvifolia* L.) and Birch (*Betula pendula* Ehrh.) were distinguished in the fourth group on the basis of average values of parametres of the bioecological analysis. What is more these three species are emphasized in the researched area as the individuals.

Green ash *(Fraxinus lanceolata* Borkh.) and Southern Catalpa (*Catalpa bignonioides* Walt.) are species separated in the fifth group of the subclusters. Southern Catalpa is a species that belongs to a tropical family, but has been introduced in many countries as ornamental. Although this plant is consumed by indigenous cultures of South America for medical uses (Muñoz-Mingarro et al., 2003). The individuals of Green ash also possess the aesthetic characteristics desired of urban trees, such as autumn color, attractive bark and flowers (Pericval et al., 2006). All the above facts are the reason of their frequent occurrence in the green areas.

As part of the sixth group, Euroamarican Poplar (*Populus x euroamericana* (Dode) Guinier) and English oak (*Quercus robur* L.) were distinguished by their height and values of decorativnesses. The species are grouped by big number and poor aesthetic values, what indicates a low values of decorativnesses. White mulberry (*Morus alba* L.), as the species that stands as the individual in the space has a high values of all parameters and as such distinguishes from the other individuals in the seventh subcluster.

In the eighth group of subclusters there were found the species that can be found in the space in a group planting and as individuals. The species that stand in the groups (*Fraxinus excelsior* L., *Platanus acerifolia* (Ait.) Willd., *Fraxinus ornus* L., *Acer platanoides* L., *Acer pseudoplatanus* L., *Fraxinus angustifolia* Vahl) have proven to be very weak and with poor values of decorativness and vitality. Although the natural en-

vironment conditions are good for them, weak measures of maintaining and bad spatial distribution caused the lower values of researched parameters of bioecological analysis. The species that are planted in groups and they are very suitable for greenery. On the other hand, Norway Maple, as the most numerous species in Smederevo fortress is located separately within subcluster of the sixth group. The species is highly resistant to dust and fumes in the air and as Vukićević (1996) considered this species is one of the most adaptable species to urban conditions. The species that stand as the individuals (*Broussonetia papyfera* L'Her. ex Vent., *Juglans regia* L.) have high value of of decorativness and vitality. What is common for all species in this subcluster is the high values of trunk diameter, ranking above 30 to 50.

In the ninth group is American Sycamore (*Platanus occidentalis* L.), which distinguish itself by its height and good assessment of vitality. It has successful growth on alluvial terrain (Vukićević, 1996). In the parks is rare species, so it's not surprising its small number in the Smederevo fortress.

And in the last group of sublusters following species were located: Eurasian aspen (*Populus tremula* L.), Blue Spruce (*Picea pungens* Engelm.) and White mulberry (*Morus alba* L.*'Pendula'* Dipp.) All three species have similar values for evaluated parameters of bioecological analysis. According to the vitality Eurasian aspen is dominated, but number of its individuals is negligible (only one individual). The reason for this is that *Populus tremula* L. is not long-living species, and as Vukićević (1996) points out adult trees often suffer from rotten core.

CONCLUSION

Smederevo fortress, as a significant cultural and historical property, monument of culture, stated under third degree of protection, also is a valuable tourist destination and an important element of urban core of the city of Smederevo. The special contribution to its representativeness and significance is the wealth of its dendroflora. Species found in the Smederevo fortress are mostly indigenous or allochthonous adaptive to natural environmental conditions, to alluvial habitat, high humidity and moderate climate. But values of parameters of bioecological analysis were not at a high level, especially grades of vitality and decorativeness. The reason for this is a poor measure of maintaining applicable at the area. It is a common that due to poor health of species, any kind of care and maintaining is refused. When a species come to a stage of extinction, they have been removed, which makes dendrofond poorer and creates an image of a space that certainly is not appropriate for monument of this kind. Also, it was difficult to speak objectively about the examined parameters, because all species are not equally presented (in the same percentage).

It is unrealistic to talk about the relationship between deciduous and coniferous species and their impact to the aesthetic value of the space, because there is absolute dominance of deciduous species (coniferous presence is only in two individuals). The reason for this may be a better adaptability of deciduous species in the natural environmental conditions of the researched area.

Overall aesthetic and decorativeness value of the area was rated very poor. Mean value of vitality and decorativeness is the same it reaches 3. This emphasize that the species are very damaged, but with intensive care, ttheir vitality can be recovered. In the terms of decorativenesses of overall composition, it can be concluded that the trees,

at this stage of the current situation, have not emphasized aesthetic values. This can be supported with a fact that only a regular maintenance of dendrofond's health of Smederevo fortress, can provide a good aesthetic value and species longevity.

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ESTETSKA VREDNOST SMEDEREVSKE TVRĐAVE ISKAZANA KROZ PARAMETRE BIOEKOLOŠKE ANALIZE

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Izvod

Smederevska tvrđava je utvrđen srednjevekovni grad, površine oko 10,5 ha. Kao centralni gradski park, pripada kategoriji zelenih površina opšte namene. Bioekološka analiza imala je za cilj isticanje parametra važnih za ocenu estetske vrednosti prostora. Klaster analiza je primenjena u cilju determinacije relativno homogenih grupa drveća. Rezultati su pokazali da trenutno stanje biljnog fonda nije na zavidnom nivou. Dalja unapređenja prostora treba da budu usmerena u pravcu isticanja monumentalnosti biljnog fonda, kako bi se i istorija prostora opravdala.

Ključne reči: Smederevska tvrđava, estetska vrednost zelenila, bioekološki parametri.

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