RESTORATION OF JUPA PARK - LANDSCAPE AND WOOD SPECIES ANALYSIS USING GIS TECHNOLOGY

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ABSTRACT

Jupa village belongs to the municipality of Caransebes. In 1795, the Capra Mansion was built in Jupa village, an imposing building around which Jupa Park was created. Both the mansion and the surrounding park have undergone dramatic changes in the last century. A general landscape analysis was performed based on the GIS and GNSS technologies. An inventory of the wood vegetation was also made and its ornamental value and vitality were assessed. The remnant 11 taxa were identified as follows: 10 tree species (5 native and 5 exotic broadleave trees) and 1 fruit tree. The present-day park landscape is the result of the long-term interaction of the park species with anthropic activities in a rural context. In order to restore a functional green space for the local community of Jupa village, a plan of rearrangement was conceived in compliance with the landscape architecture principles.

INTRODUCTION

Jupa village belongs to the municipality of Caransebes, being situated 5 km North of Caransebeș town. The village is crossed by the national road DN6. In the Northern part of the Jupa village, the Archaeological Reserve Tibiscum (17 ha) is located, where the ruins of an ancient roman settlement (*castrum*) can be seen (Academia Română, 2013). Jupa village was mentioned for the first time in documents in 1369 (Benea, D., Bona, P., 1994). The Capra Mansion was built in Jupa village in 1795. It was an imposing building around which the Jupa Park was created. Both the mansion and the surrounding park have undergone dramatic changes in the last century. In the communist period, the Capra Mansion was nationalized. Between 1994 and 2002, this imposing building was administered by the *County Museum of Ethnography and the Border Regiment*, an institution that did not have enough funds to finance expertise and restoration. Between 2002 and 2009 both Capra Mansion and Jupa Park were administered by the Municipality of Caransebeș. In 2009 the Capra Mansion was sold. The owner restored the building following the procedures for the restoration of historical monuments. There is a positive attitude of the local authorities. Later, they named the street which leads to the old park, Alexandru Capra de Jupa, after the first owner and commanded a detailed study concerning the vegetation of the village, wanting to protect and preserve the valuable trees and to invest in the rearrangement of the old park. The aim of this study is to evaluate the diversity of wood species which exist in the Jupa Park, to propose a new plan of

rearrangement of the park and to create a new functional green space, which could satisfy the needs of the local community.

MATERIAL AND METHOD

In order to make direct observation, take pictures and analyze the park, field visits were made. The GNSS technology used together with a GIS data acquisition tool in the field was composed of a Leica GPS Zeno 20 dual frequency receiver and the Collector for ArcGIS software (Herbei, M.V., Sala, F., 2016). Data collected from the field was stored in spatial databases that, besides the Cartesian coordinates of the trees, also store the characteristic attributes that were collected distinctly for each measurement (species, height, diameter, vitality). Data collection at the office was made using ESRI's ArcGIS software. The ornamental value and vitality of wood vegetation, expressed on a decimal scale (0 - dry, 10 - healthy trees), were analyzed. For this purpose the usual dendrometric measurements for the inventoried tree individuals (height, diameter) have been performed. Average heights/species, average diameter/species and average vitality/species were calculated. In order to create a functional green space for the local community, two new plans of rearrangement of Jupa Park were conceived in compliance with the landscape architecture principles.

RESULTS AND DISCUSSIONS

A GIS map with the green area information was realized in order to have an actual image of the Jupa Park. The measured area is 12722,04 m^2 (Fig. 1). This area is called unproperly Jupa Park, because there are no alleys, outdoor furniture or ornamental elements, which are characteristic for modern green areas. Most of the trees are planted in groups, along the perimeter of the park. From the old dendrological park, some tree individuals still exist today. These trees represent a proof that this area was once a dendrological park (Fig. 2).

A total of 11 taxa were identified as follows: 10 broadleave tree species (5 native - 29 individuals and 5 non-native - 20 individuals) and 1 fruit tree species (6 individuals).

Of the total number of 57 individuals there are: *Gingko biloba* (1)*, Populus alba* (1), *Tilia platiphyllos* (1)*, Celtis occidentalis* (1), *Catalpa bignonioides (2), Fraxinus excelsior (2), Prunus domestica* (6), *Juglans nigra* (7), *Tilia cordata* (8), *Platanus X acerifolia* (9) and *Tilia tomentosa* (17). Two trees are dry. Coniferous species and shrubs were not identified in the park (Fig. 3).

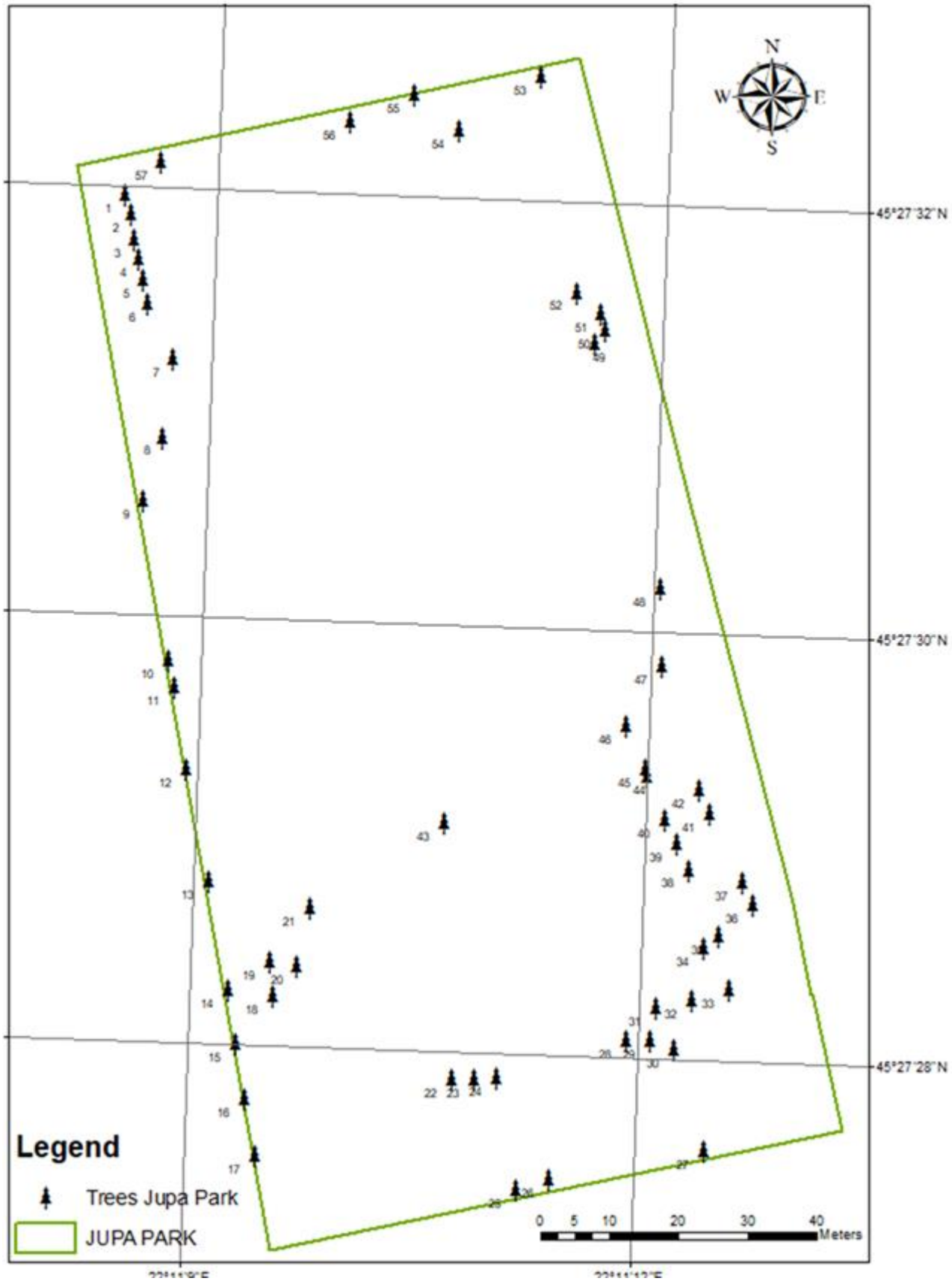

Fig. 1 Jupa Park map

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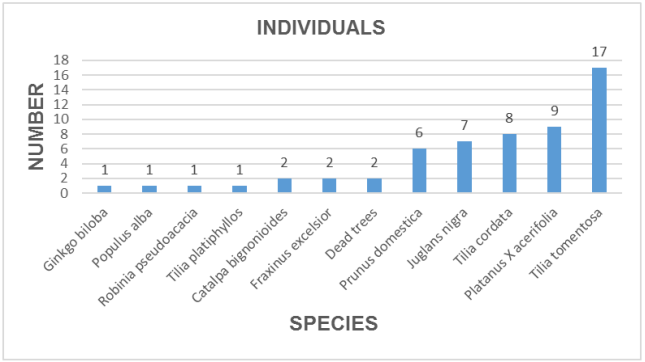
Fig. 2 Jupa Park nowadays



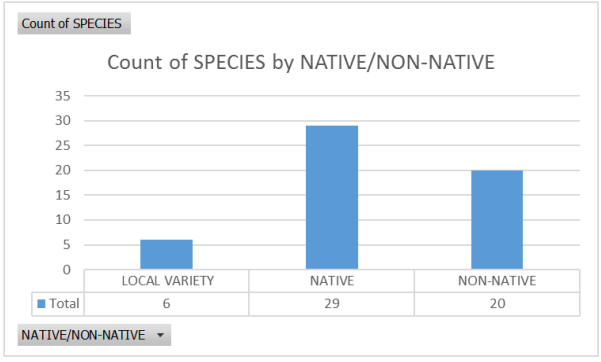


Fig. 3 Wood species - Jupa Park

Geographic coordinates, the dendrometrical characteristics and vitality of the identified trees are presented in Table 1.

Table 1

Geographic coordinates, dendrometrical characteristics and the vitality of native and non-native wood species recorded in Jupa Park

UNIC IDENTIFIER	X[m]	Y[m]	Z[m]	SPECIES	NATIVE/NON-NATIVE	DIAMETER (cm)	HIGH (m)	VITALITY (1-DRY; 10-HEALTHY)
34	443631.596	280030.576	185.86	/	/	/	/	1
35	443633.274	280032.78	185.9	/	/	/	/	1
8	443705.501	279952.401	185.8	*Catalpa bignonioides*	NON-NATIVE	36	10	8
7	443716.85	279953.78	186.54	*Catalpa bignonioides*	NON-NATIVE	36	10.5	7
27	443602.163	280030.678	186.6	*Fraxinus excelsior*	NATIVE	86	28	10
53	443757.666	280007.217	185.35	*Fraxinus excelsior*	NATIVE	74	21	5
43	443649.753	279993.092	104.64	*Ginkgo biloba*	NON-NATIVE	36	15.5	10
52	443726.449	280012.342	185.51	*Juglans nigra*	NON-NATIVE	78	32	10
20	443629.019	279971.858	163.96	*Juglans nigra*	NON-NATIVE	72	34	10
18	443624.674	279968.344	169.51	*Juglans nigra*	NON-NATIVE	86	26	9
50	443720.903	280016.347	185.54	*Juglans nigra*	NON-NATIVE	80	36	9
19	443629.719	279967.829	185.72	*Juglans nigra*	NON-NATIVE	82	35	8
51	443723.346	280015.893	185.53	*Juglans nigra*	NON-NATIVE	52	25	7
49	443718.956	280014.851	185.55	*Juglans nigra*	NON-NATIVE	42	25	7
16	443609.711	279964.264	185.89	*Platanus X acerifolia*	NON-NATIVE	58	30	10
9	443696.282	279949.438	185.17	*Platanus X acerifolia*	NON-NATIVE	84	25	9
12	443657.568	279955.871	185.49	*Platanus X acerifolia*	NON-NATIVE	46	23	9
13	443641.4	279958.955	185.63	*Platanus X acerifolia*	NON-NATIVE	52	28	8
14	443625.548	279961.736	185.76	*Platanus X acerifolia*	NON-NATIVE	46	24	8
17	443601.656	279965.784	185.96	*Platanus X acerifolia*	NON-NATIVE	40	17	8
11	443669.281	279954.011	185.39	*Platanus X acerifolia*	NON-NATIVE	48	22	7
15	443617.881	279963.001	185.82	*Platanus X acerifolia*	NON-NATIVE	38	21	7
10	443673.292	279953.129	185.36	*Platanus X acerifolia*	NON-NATIVE	40	9	5
21	443637.342	279973.622	155.02	*Populus alba*	NATIVE	145	36	7
2	443737.687	279947.903	185.41	*Prunus domestica*	LOCAL VARIETY	16	6	8
3	443734.146	279948.161	185.39	*Prunus domestica*	LOCAL VARIETY	16	5.5	8
5	443728.256	279949.524	185.35	*Prunus domestica*	LOCAL VARIETY	16	5	8
4	443731.281	279948.947	185.37	*Prunus domestica*	LOCAL VARIETY	15	5	8
1	443740.581	279946.927	185.42	*Prunus domestica*	LOCAL VARIETY	10	4	7
6	443724.839	279950.239	185.33	*Prunus domestica*	LOCAL VARIETY	10	3.5	5
55	443755.049	279988.791	185.38	*Celtis occidentalis*	NON-NATIVE	28	22	9
38	443642.919	280028.568	185.91	*Tilia cordata*	NATIVE	50	27	9
47	443672.294	280024.627	185.71	*Tilia cordata*	NATIVE	48	27	8
41	443650.941	280031.473	185.62	*Tilia cordata*	NATIVE	44	29	8
39	443646.681	280026.696	185.79	*Tilia cordata*	NATIVE	36	22	8
42	443654.545	280030.055	185.51	*Tilia cordata*	NATIVE	46	27	7
22	443612.521	279994.231	185.58	*Tilia cordata*	NATIVE	124	21	5
26	443598.137	280008.134	186.01	*Tilia cordata*	NATIVE	68	16	5
37	443641.02	280036.313	186	*Tilia cordata*	NATIVE	46	16	5
29	443618.176	280022.97	185.78	*Tilia platiphyllos*	NATIVE	48	28	9
25	443596.621	280003.385	185.88	*Tilia tomentosa*	NATIVE	102	32	9
44	443656.436	280022.389	185.55	*Tilia tomentosa*	NATIVE	56	38	9
45	443657.48	280022.212	185.54	*Tilia tomentosa*	NATIVE	56	35	9
24	443612.86	280000.735	185.55	*Tilia tomentosa*	NATIVE	54	27	9
32	443623.985	280028.905	185.77	*Tilia tomentosa*	NATIVE	52	27	9
31	443622.978	280023.696	185.69	*Tilia tomentosa*	NATIVE	48	27.5	9
28	443618.237	280019.505	185.69	*Tilia tomentosa*	NATIVE	48	26	9
33	443625.464	280034.379	185.99	*Tilia tomentosa*	NATIVE	42	28	9
57	443745.311	279952.224	185.45	*Tilia tomentosa*	NATIVE	28	16.5	9
56	443751.239	279979.528	185.4	*Tilia tomentosa*	NATIVE	28	14.5	9
23	443612.559	279997.478	185.57	*Tilia tomentosa*	NATIVE	36	24	8
40	443650.191	280024.981	185.73	*Tilia tomentosa*	NATIVE	98	28	7
46	443663.817	280019.427	185.61	*Tilia tomentosa*	NATIVE	46	28	7
36	443637.923	280037.82	186.02	*Tilia tomentosa*	NATIVE	37	24	7
30	443616.917	280026.447	185.87	*Tilia tomentosa*	NATIVE	35	29	7
48	443683.528	280024.338	185.6	*Tilia tomentosa*	NATIVE	84	24	5
54	443749.816	279995.203	185.37	*Tilia tomentosa*	NATIVE	46	24	5

The vitality analysis shows that out of the 57 individuals: 2 are dry and must be extracted; 8 have low vitality (5) and they are attacked by diseases (ex: *Fraxinus excelsior)*; 12 have medium vitality (7) and they need correction cuttings (ex: *Catalpa bignonioides* and *Populus alba)*; 35 have good vitality (8 ex: *Fraxinus excelsior, Ginkgo biloba, Celtis occidentalis).* In order to highlight the distribution of trees according to their vitality, a GIS map was realized (Fig. 4).

The average vitality/species was calculated. The best results concerning vitality (8,57) are displayed by *Juglans nigra* with healthy individuals, well adapted and having high ecological value (Fig. 5).

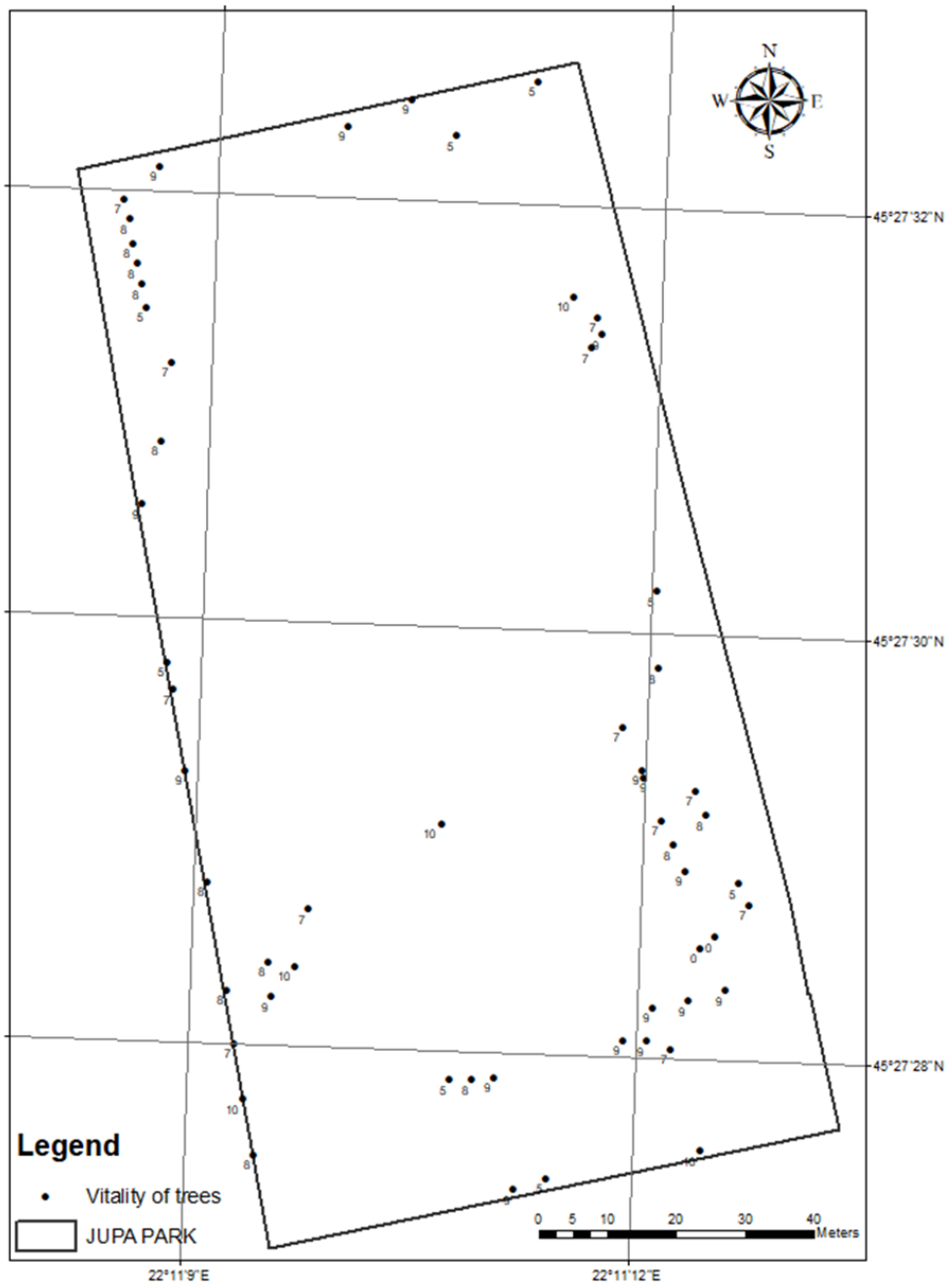
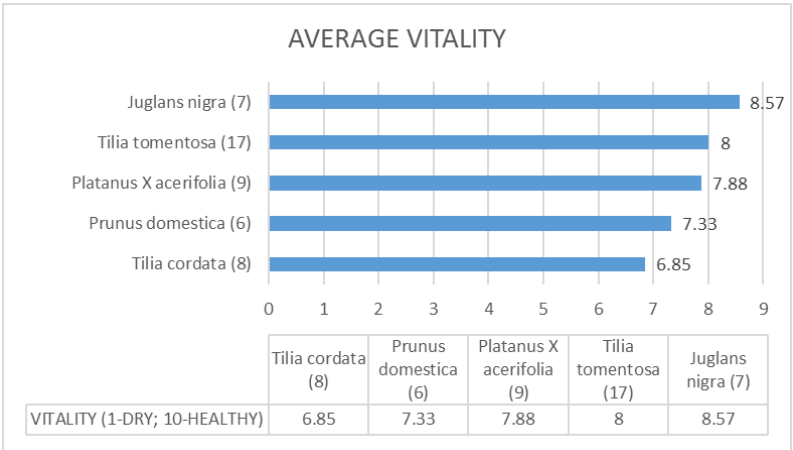


Fig. 4 Vitality of trees in Jupa Park (levels 1-10)



	Tilia cordata (8)	Prunus domestica (6)	Platanus X acerifolia (9)	Tilia tomentosa (17)	Juglans nigra (7)
VITALITY (1-DRY; 10-HEALTHY)	6.85	7.33	7.88	8	8.57

Fig. 5 Average vitality/species

Biometric data analysis shows that out of 57 individuals: 10 individuals are between 1-15 m tall (ex: *Catalpa bignonioides* = 10,5 m); 5 individuals are between 15,5 -20 m tall (ex: *Ginkgo biloba* = 15,5 m) and 40 individuals are between 21-38 m tall (ex: *Celtis occidentalis* = 22 m, *Tilia platiphyllos* = 28 m, *Fraxinus excelsior* = 28 m). The tallest trees are: *Tilia tomentosa* (38 m), *Populus alba* (36 m), *Juglans nigra* (36 m), *Juglans nigra* (35 m), *Tilia tomentosa* (35 m) and *Juglans nigra* (34 m). **Average height/species** was calculated showing that *Prunus domestica* has the lowest average height. *Juglans nigra, Tilia tomentosa, Tilia cordata and Platanus x acerifolia* individuals are high trees having an average height over 22 m (Fig. 6).

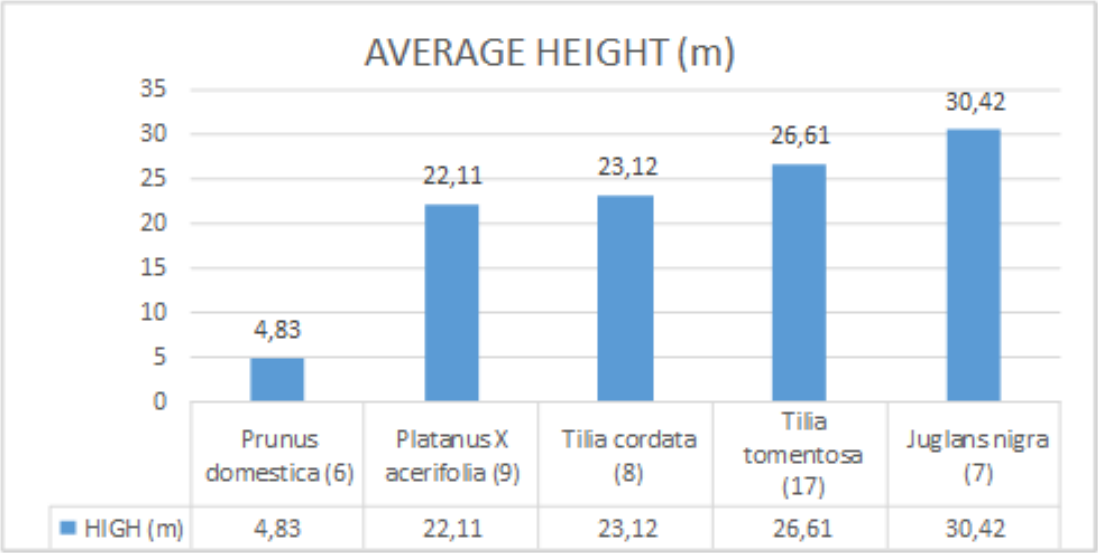


Fig. 6 Average heights/species in Jupa Park

Diameter analysis highlights that 6 individuals have diameters smaller than 20 cm (*Prunus domestica*); 13 individuals have diameters between 20-40 cm (ex: *Celtis occidentalis* = 28 cm, *Catalpa bignonioides* = 36 cm, *Ginkgo biloba* = 36 cm); 22 individuals have diameters between 40-60 cm (ex: *Tilia platiphyllos* = 48 cm) and 14 individuals have diameters above 60 cm (ex: *Fraxinus excelsior* = 86 cm). 3 individuals were identified having outstanding diameters above 100 cm: *Tilia tomentosa (102 cm), Tilia cordata (124 cm) and Populus alba (145 cm).* Average diameters of individuals/species were also calculated (Fig. 7).

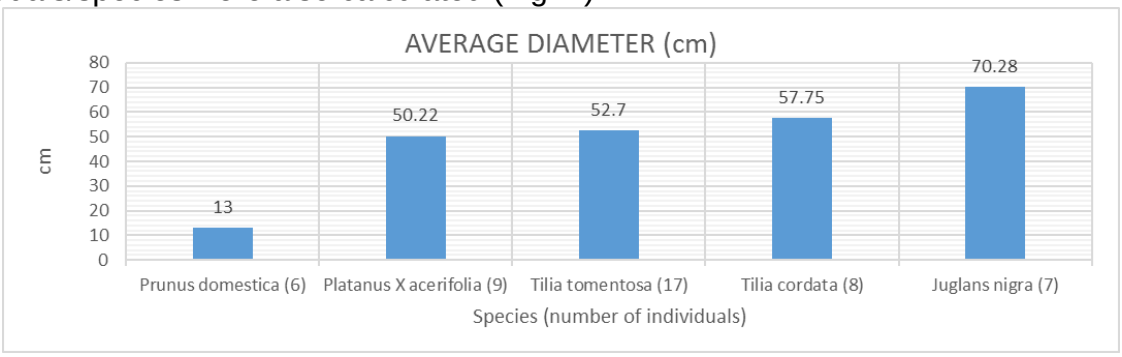


Fig. 7 Average diameter/species

The analysis showed that planning could turn this old park into a healthy and agreeable place for the visitors. In order to improve the image and the function of Jupa Park some measures are necessary:

- *Maintaining the existing tree individuals and improving their aesthetics* by doing the necessary maintenance works (Swaffield, S.R., 2002). Most of the trees are remarkable,

having outstanding dimensions and vitality and high ornamental and ecological value. In order to maintain and prolong their life, they should be monitored periodically.

- *Remodelling the existing sections of the park* by eliminating the individuals which have dried (Notteboom B., 2017). The two dead trees should be extracted. The challenge for the future is to increase the biodiversity by introducing new taxa in the park. (Tenche-Constantinescu, A.-M., Szekely, G., Borlea, Gh. F., 2016). In this respect we have proposed to plant turf and flower beds with special shapes and new shrub and tree species;

- *Establishing the Jupa Park infrastructure* by creating alleys in the park, creating a playground for children, creating an ecological parking for cars and bicycles, installing benches, waste bins, drinking fountains, ecological toilets and street lamps - reflectors.

In this respect, in order to create a new functional green space, *two new plans in compliance with the landscape architecture principles (P1 and P2)*, were conceived (Fig. 8).

Fig. 8 Jupa Park - Plan of rearrangement
P1 - Stud. Murgilă Mirabela; P2 - Stud. Heler Talita, 3rd year, Landscape Architecture, Coordinator lect. Țenche-Constantinescu Alina-Maria PhD., 2017

Plan 1 is designed in geometric style with 4 access ways and straight alleys. We propose to plant new species such as: *Abies concolor* (1), *Larix decidua* (3), *Picea abies* (5), *Pinus strobus* (6), *Taxus baccata* (10), *Juniperus sabina* (6), *Aesculus hippocastanum* (3), *Albizia julibrissin* (6), *Liriodendron tulipifera* (4), *Liquidambar striaciflua* (2), *Magnolia Kobus* (26) and *Lavandula angustifolia* (10). The playground for children is planned to include carousel (1), slides (2), cradles (2) and a sports ground. It is proposed to install drinking fountains (2), artesian fountain (1), benches (31), waste bins (12), ecological toilet (1) and street lamps - reflectors (20).

Plan 2 is designed in English style with 2 access ways and sinuous alleys. We propose to plant new species such as: *Dianthus grandiflorus* (30), *Aster Lady in Blue* (30), *Juniperus procumbens Nana* (8), *Juniperus sabina Tamariscifolia* (6), *Ligustrum vulgare*

(380), *Acer palmatum Atropurpureum* (1), *Corylus maxima* (1), *Pseudotsuga mensienzii* (3), *Albizzia julibrissin* (1), *Magnolia kobus* (3), *Quercus rubra* (2), *Liquidambar styraciflua* and *Fagus sylvatica Roseomarginata* (2), *Acer negundo Kellys Gold* (1), *Acer sacharinum (2), Aesculus hippocastanum (1), Alnus glutinosa (1), Koelreuteria paniculata* (5), *Liriodendron tulipifera* (4), *Prunus serrulata* (4) and *Robinia pseudoacacia var. Frisia* (1). The playground for children is planned to include carousel (1), slides (1), cradles (1) and see saw (1). It is proposed to install drinking fountains (2), benches (19), chess tables (4), waste bins (11), ecological toilets (2) and street lamps - reflectors (25).

Implementing modern ideas in the park can help ecology become a major issue for the village. Biodiversity will increase by introducing new taxa in the park. The future plan should include existing valuable trees, should have a cultural value, and should use modern urban furniture. In the meantime, the park will become more functional. A green area with centres of interest and defined directions, with ornamental vegetation with high ecological value, would be a real delight for the locals, a functional unitary space, harmoniously integrated into the local landscape.

CONCLUSIONS

The Jupa Park covers an area of 12722,04 m^2. In this area 57 tree individuals are planted in groups, along the perimeter of the park. In the central area, there is an isolated *Gingko biloba* which has high ornamental value (15,5 m tall, 36 cm diameter) and very good vitality. Of the total number of 57 individuals, the most significant presence in the area is *Tilia* genre with 26 individuals. Some of the trees are remarkable, of a great size, with a great ecological and ornamental value such as: *Tilia tomentosa* (32 m tall, 102 cm diameter and vitality 9), *Fraxinus excelsior* (86 cm diameter 28 m tall, and vitality 10), *Juglans nigra* (86 cm diameter, 26 m tall and vitality 9), *Juglans nigra* (36 m tall, 80 cm diameter and vitality 9), *Platanus X acerifolia* (30 m tall, 58 cm diameter and vitality 10), *Platanus X acerifolia* (25 m tall, 84 cm diameter and vitality 9), *Platanus X acerifolia* (23 m tall, 46 cm diameter and vitality 9), *Populus alba* (36 m tall, 145 cm diameter and vitality 7), *Celtis occidentalis* (22 m tall, 28 cm diameter and vitality 9), *Tilia cordata* (27 m tall, 50 cm diameter and vitality 9), *Tilia tomentosa* (32 m tall, 102 cm diameter and vitality 9), *Tilia tomentosa* (35 m tall, 56 cm diameter and vitality 9) and *Tilia tomentosa* (38 m tall, 56 cm diameter and vitality 9). Coniferous and shrubs species were not identified in the park. The challenge for the future is to increase the biodiversity by introducing new taxa in the park. There is an obvious interest of the local authorities for the improvement of Jupa Park. A detailed study concerning the vegetation of the park was decided to be performed. If one of the two plans of rearrangement will be implemented, the attractiveness of Jupa Park will increase and the newly created public space could host different social and cultural events in accordance with people's expectations and ecological principles.

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BIBLIOGRAPHY

1. **Academia Română,** 2013 - *Istoria Românilor Vol. 2. Daco-Romani, Romanici, Alogeni*, Editura Univers Enciclopedic, 996 p.;
2. **Benea, D., Bona, P.,** 1994 - *Tibiscum*, Ed. Museion, București;

3. **Herbei, M.V., Sala, F.,** 2016 - *Biomass prediction model in maize based on satellite images*. In AIP Conference Proceedings, Vol. 1738, No. 1, 350009, AIP Publishing;
4. **Notteboom B.,** 2017 - *Residential landscapes - Garden design, urban planning and social formation in Belgium*, Urban Forestry & Urban Greening;
5. **Swaffield, S.R.,** 2002 - *Theory in Landscape Architecture*, Ed. University of Pennsylvania Press, 265 p., U.S.A., Philadelphia;
6. **Tenche-Constantinescu, A.-M., Szekely, G., Borlea, Gh. F.,** 2016 - *Improving the urban image of the town of Caransebeş by the extension of green spaces and pedestrian areas in the city centre,* Journal of Horticulture, Forestry and Biotechnology, Volume 20(2), p. 100-111, Timişoara.