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TOWARDS SUSTAINABLE URBAN GREEN AREAS: TREE INVENTORY IN GROZĂVEȘTI PARK (BUCHAREST, ROMANIA) FOR REVITALIZATION USING WATER-EFFICIENT APPROACHES

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Abstract

The Romanian law fails to give exact methodologies for the landscape study, planning, and management. Grozăvești Park is part of the strategy for increasing the amount and quality of green areas in District 6 in Bucharest, Romania. It also has the potential of an urban green pole, and will be integrated into the future green corridor of District 6. Considering the specific site conditions, as the metro under the park has water infiltrations, water scarcity and climate changes in Bucharest, there is a need for water-efficient approaches. To assess and protect the current park, comprehensive site analyses were carried out in spring 2024. The vegetation study identified 583 trees with 104 being dead or non-viable, leaving 479 viable trees. From the site analyses, topography and vegetation study, there was a clearer view for what set of recommendations to follow for the revitalization program of the park. The inventory of trees helped to identify young and mature trees that require irrigation and to select appropriate new plant species for efficient water usage.

Key words: *tree inventory, irrigation, green areas, water-efficient approaches, park revitalization.*

INTRODUCTION

At the level of the Municipality of Bucharest, the area occupied by green spaces must be expanded to reach the minimum limit imposed by the Ordinance of Emergency no. 195/2005 on environmental protection, respectively of 26 sqm/inhabitant. According to the Register of Green Spaces updated in 2011, the surface of green space per capita in Bucharest was 8.89 sqm/inhabitant (PIDU, 2021).
District 6 of Bucharest City Hall strategy is to increase the amount and quality of urban green areas in the District. Therefore, the revitalization of Grozăvești Park is under discussion.
This park was built around 1980 during the metro building. It is believed that most of the level difference comes from using ruins from the 1977 earthquake (Oanţă-Marghitu, 2012). Today, the Park is mainly crossed by users of the metro, these being forced to pass through a highly degraded landscape, partly resulting from some landslides, poor management, invasive species and vegetation not adapted to climate changes. Due to the Metro water infiltrations, water scarcity and climate changes in Bucharest, there are restrictions for using irrigation in this Park, therefore the concept for revitalization should follow water-efficient approaches and nature-based solutions. According to the Romanian Law (HG 907/2016), for an existing urban green area revitalization there is a minimum set of studies needed including: topography, geology and landscape. Unfortunately, the Romanian law fails to give exact methodologies for the landscape study, and for conducting a tree inventory. For the landscape study it is advisable to have all the information from: topography, geology, history of the site, tree inventories to visual analysis.
In recent years, there has been a higher interest regarding urban tree inventories, driven by challenges associated with pest and disease infestations in urban tree populations, alongside an increasing recognition among decision-makers of the diverse ecosystem services offered by trees within urban environments (Nielsen et al., 2014).

According to the Romanian Law 24/2007 on the regulation and management of green spaces, local public administration authorities are responsible for maintaining records of green spaces and vegetation inventories are required components of local green registries. The local green registries must be regularly updated to reflect any changes. However, Romanian local administrations often struggle to furnish accurate data regarding their managed green areas, resulting in inadequate planning and management of green spaces. Consequently, there is a notable decline in the ecological and aesthetic integrity of these areas (Morar et al., 2019; Morar et al., 2020).
Tree inventory systems serve as comprehensive tools for assessing the present and historical state of green areas, offering essential data for the development of planning and management strategies. Functioning as decision-making tools, these inventories compile vital parameters including: tree species, dimensions, health status, risk assessment, and spatial distribution (Ma et al., 2021).
In terms of dimensions, an easy to measure and commonly used is the diameter of trees at breast height - DBH (Cosovic, 2022); typically measured at 1.3 or 1.4 m above ground level, depending on regional professional standards. Beyond its inherent utility, tree diameter serves as a predictive metric for various other parameters, including such as tree growth, canopy spread, trunk flare, and tree height (Ma et al., 2021). Information on tree species condition and maintenance needs are also gathered (Ma et al., 2021).
Tree inventories are commonly conducted by arborists, urban foresters, landscape architects and other qualified experts. Additionally, community or citizen science initiatives, which involve the general public in tree data collection, have been observed with differing degrees of success (Ma et al., 2021; Roman et al., 2017). The precision of a tree inventory dictates the management decisions that can be derived from it. In comparison to data collected by professionals, the accuracy of information gathered by public volunteers may vary, potentially impacting its intended utility (Ma et al., 2021).
There are different strategies for efficient water usage in green spaces, including appropriate plant species (Rabbani KheirKhah and Kazemi, 2015).

MATERIALS AND METHODS

General descriptions of site

The study area is Grozăvești Park in the western part of Bucharest, District 6 (Figure 1). The climate in the southern region of Romania is a temperate climate with Mediterranean influence (Pârvu, 1980), but general mean temperatures are around 10.2-11.9oC; 400-500 mm annual rainfall (April and May with the highest amounts); 80-100 days with drought. During summer, the received water is 3-4 less than consumed water, resulting in aridity. To estimate climate trends, consideration was given to the projected changes for Europe regarding the Mediterranean climate impact drivers (Bednar-Friedl, 2022).

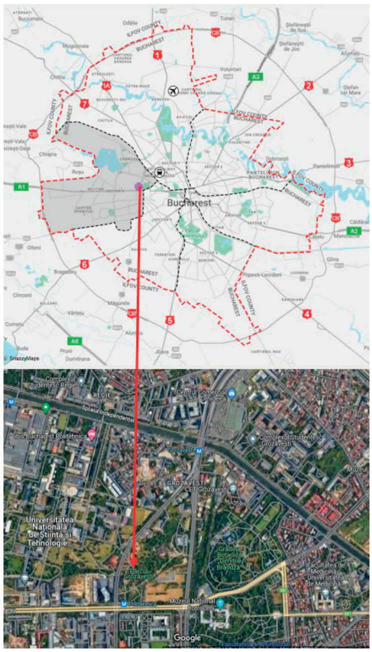

Figure 1. Grozăvești Park location - fitting into the context at the urban level of Bucharest (adapted from online maps)

The main destinations of the park will be recreation through quality landscaping and socialisation by creating a suitable setting with vegetation and urban amenities to facilitate sports, to encourage a healthy lifestyle, and other types of events that bring people together and create communities.

As it may be observed in Figure 2, Grozăvești Park is divided in 2 areas; the red dotted area is administered by the District 6 City Hall, while the blue area is privately owned. The total land surface has around 35,360 sqm.

Figure 2. Grozăvești Park location (red dotted is the actual studied area administrated by the District 6 City Hall, while the blue dotted is private)

Topographic study

During the planning phase of tree inventory process, GNSS RTK receivers were used to retrieve control points in the national coordinate system that were used for georeferencing, verification and constraint of determinations made with 3D laser scanning systems as well as for determinations made with the total station where there was no coverage from scanning. The 3D laser scanning systems contain state-of-the-art calculation algorithms and allow the creation of a model of the study area, with a relative accuracy of +/- 2 cm. The total station was used to fill the network of control points, where the environment was unfavourable for GNSS determinations, as well as to take over the detail points where, after the Lidar data post-processing, it was found that there was not enough coverage. Afterwards, the verification and constraint of the cloud was carried out on points obtained on control points and cloud generation end points, uncolored. The point clouds were imported into the CAD platform where the elements of interest were vectorized, the surfaces were calculated and the linear dimensions and reality were checked for compliance with the cadastral contours of the buildings of interest, these being extracted from the E-terra computer system. The topography CAD version was used for determining the location of trees and zoning (Figure 3).

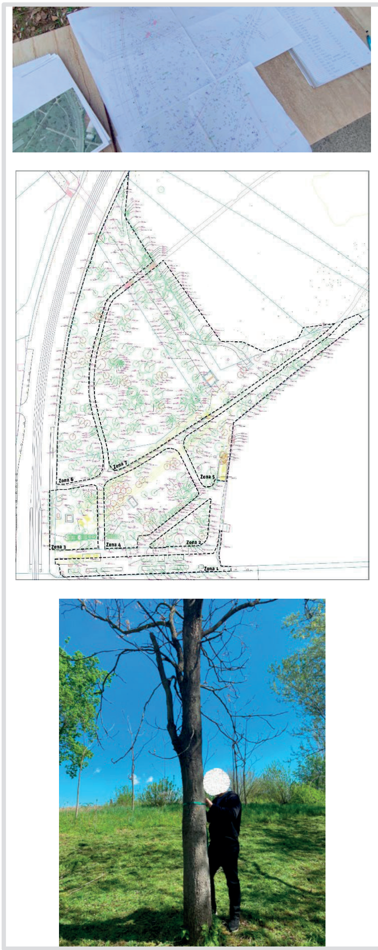

Figure 3. Tree field data location, zoning and collection by walking

Tree inventory

The study was conducted by three landscape architects with the help of five students from urbanism and landscape architecture for a total of four days of field study. Tree data was collected from the field during two periods: February 2024 (identification of tree genera) and April 2024 (inventory of tree species and other characteristics). In February due to winter conditions some species could not be determined, thus a new inventory to check was done during the vegetation period in April. Data collected for the tree inventory: species, DBH at 1.3, and viability. General visual and aesthetic analysis was conducted also in October 2023. All the data collected from the field was then added to the CAD file, and excel lists.

RESULTS AND DISCUSSIONS

The topographic analysis provided precise geospatial data for individual trees and detailed information about the site's terrain. While 3D imagery offered an overview of the site's general layout (Figure 4).

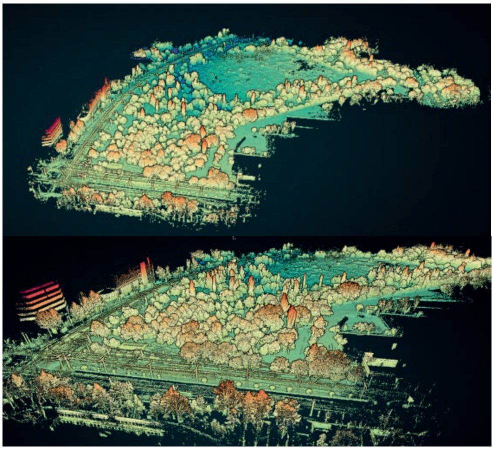

Figure 4. Location of existing woody vegetation

The tree inventory shows that in Grozăvești Park there are 583 trees, out of which 104 are death/non-viable, resulting in 479 viable trees.
There were 25 genus found during the inventory, out of which the most common Genus are *Populus*, followed by *Pinus, Thuja, Platanus, Pyrus and Tilia* (Table 1).
The assortment of trees belonging to the Genus presented in Table 1 are tolerant of dry soils, with the exception of *Thuja* (requiring moist to wet soil) and *Pyrus* (moist soil). There were 31 species found, out of which most common species representing around 50% of the total trees are: *Pinus nigra, Populus alba, Thuja* sp., *Platanus acerifolia, Tilia tomentosa* and *Pyrus* sp. (Table 2).

Table 1. Most common Genus

No	Genus	Frequency of counted cases	Dead Tree	Viable Tree	Percent of total viable cases (%)
1	*Populus*	77	5	72	15.03
2	*Pinus*	95	37	58	12.11
3	*Thuja*	53	6	47	9.81
4	*Platanus*	43	0	43	8.98
5	*Pyrus*	41	3	38	7.93
6	*Tilia*	40	2	38	7.93
7	*Ailanthus*	38	8	30	6.26
8	*Fraxinus*	35	7	28	5.85
9	*Acer*	34	7	27	5.64
10	*Prunus*	27	3	24	5.01
11	*Gleditsia*	25	2	23	4.80

Table 2. Most common species

No	Species	Frequency of counted cases	Dead tree	Viable tree	Percent of total viable cases (%)
1	*Pinus nigra*	94	37	57	11.90
2	*Populus alba*	56	5	51	10.65
3	*Thuja* sp.	53	6	47	9.81
4	*Platanus acerifolia*	43	0	43	8.98
5	*Tilia tomentosa*	40	2	38	7.93
6	*Pyrus* sp.	41	3	38	7.93
7	*Ailanthus altissima*	38	8	30	6.26
8	*Fraxinus* sp.	35	7	28	5.85
9	*Acer* sp.	30	5	25	5.22
10	*Gleditsia triacanthos*	25	2	23	4.80
11	*Populus nigra* Italica	21	0	21	4.38
12	*Prunus cerasifera*	23	2	21	4.38
13	*Carpinus betulus*	14	1	13	2.71
14	*Malus* sp.	17	4	13	2.71
15	*Aesculus hippocastanum*	4	0	4	0.84
16	*Ulmus minor*	4	0	4	0.84
17	*Juglans nigra*	5	1	4	0.84
18	*Prunus cerasifera Pissardii*	3	0	3	0.63
19	*Alnus* sp.	2	0	2	0.42
20	*Cydonia oblonga*	2	0	2	0.42
21	*Quercus robur*	2	0	2	0.42
22	*Salix matsudana* 'Tortuosa'	3	1	2	0.42
23	*Acer negundo*	4	2	2	0.42
24	*Betula pendula*	1	0	1	0.21
25	*Picea* sp.	1	0	1	0.21
26	*Pinus strobus*	1	0	1	0.21
27	*Ulmus pumila*	1	0	1	0.21
28	*Morus* sp.	2	1	1	0.21
29	*Salix babilonica*	3	2	1	0.21
30	*Robinia pseudoacacia*	11	11	0	0.00
31	*Prunus avium*	1	1	0	0.00
32	Unidentified	3	3	0	0.00
	Total	583	104	479	100

Pinus nigra species has the highest number of losses (39% of total *Pinus* specimens). According to European Atlas of Forest Tree Species, the Climate warming exacerbates water stress, which adversely affects the growth of this species. *P. nigra* is unusually tolerant of heat and summer drought needing watering planning within Grozăvești Park natural conditions. *P. nigra* 'Nana' is tolerant of drought, heat, and wind, being an alternative to be considered for park revitalization. An additional factor could be pest infestations or diseases, but this requires further examination by phytosanitary experts to confirm.

Fraxinus sp.: *F. excelsior* and cultivars require moist to wet soils; *F. pennsylvanica* and *F. velutina* require dry soil.

Acer negundo and cultivars need moist to wet soils. *A. negundo* tolerates flooding (a probable phenomenon during April and May, in the lowest parts of the park).

The most important result of the study was the extremely low frequency of *Quercus*, knowing that most species of this genus are adapted to dry soil conditions.

CONCLUSIONS

Grozăvești Park has the potential of an urban green pole due to existing mature vegetation, being possible to be integrated into the future green corridor of District 6. The vision of the project is to improve the quality of life of the inhabitants and increase urban resilience.

The existing vegetation was generally in good condition, with the exception of 104 dead specimens (mostly *Pinus* species) that were proposed for removal. The high number of dead trees was probably due to poor maintenance, possibly climate changes and orographic drought. For the vegetation that will be preserved, it is recommended to apply sanitary cuts to remove dry or broken branches.

The site's advantage of having mature indigenous species adapted to the climatic conditions was exploited for revitalization project proposal

In the concept for the revitalization of the Grozăvești Park, the existing vegetation was taken into account, keeping it mostly in the same form (but anticipating the dimensions after pruning).

The proposed species were mostly indigenous or naturalised species, both broadleaves and conifers to ensure a redundant decoration. Also, the proposed shrub species were indigenous species, adapted to the urban environment and drought soil site conditions in addition to their ornamental value.

After completion of the rehabilitation works, it is recommended to conduct a re-inventory of the young and mature trees and create a management plan for the park to track the effects of the investment over time.

Also, we recommend to use inventory of trees as a tool when tree intervention permits are issued. The results of this research will form the basis of the documentation necessary for the preparation of the Grozăvești Park Differentiated Management Plan, which will also show the design and maintenance priorities in the short-term, as well as the programming of interventions in the medium and long term. There is also the need for ongoing research to complete the database necessary for developing a tailored management plan for each category of elements, both vegetal and mineral, that constitute the landscape of Grozăvești Park.

In addition to the functions of relaxation and socialisation, Grozăvești Park can be transformed into a sustainable green space that can cope with environmental changes and help increase the area's attractiveness and economic development by valuing the existing vegetation and developing it with new tree planting that increase species and age diversity.

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