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SUSTAINABLE DEVELOPMENT AND MANAGEMENT OF GREEN SPACES FOR THE TIMISOARA MUNICIPALITY

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Abstract – Landscaping is a central concern of the contemporary world, imposing itself as an objective necessity for the coordination of multiple interests that interfere in the same territory and the rational use of resources, as a generating factor of development.
The ecological planning of the territory must ensure the harmonious development of the territory, the rational, balanced distribution of green spaces based on the organic combination of social criteria and those of economic efficiency that allow obtaining solutions necessary to achieve the following objectives:
- reduction of investment expenses for the arrangements and constructions necessary for the development and complex equipping of the territory;
- reducing the movement of goods by bringing the places of production closer to the raw materials or to the places of consumption of the products;
- the functional planning of the territory that allows the superior exploitation of the existing ecological potential;
- the maximum utilization of the territory by creating recreational places;
- maintaining the circuit of all existing or potential elements in the territory;
- the realization of a circulation and transport system for goods and people to ensure fast, short and cheap transport links on non-polluting fuels;
- the discovery of natural wealth and the creation of the conditions for their valorization through the development of green spaces.
In this context, in the present paper, a study was carried out on the development of green spaces by zones, neighborhoods and parks within the municipality of Timișoara, in parallel with the inventory of all existing green areas that will be developed in the near future.
Keywords: topographic survey, green spaces management

1. INTRODUCTION

From an urban point of view, the territory represents the geographical space that refers to urbanized, agricultural or natural areas, on which the design, regulation and development of the built environment are carried out. The challenge of territorial planning is, at present, saving green surfaces from the invasion of asphalt and concrete, driven by economic requirements. Due to this fact, the local public administration is responsible for outlining a framework that ensures development at the local level, by transforming localities "into the engine center of the development of society from an economic, political, social and cultural perspective".

These concerns are in the sphere of urban management and strategy, being integrated into the general objectives of economic-social development inscribed in urban dynamics. Within the processes that give content to urban management, the development of development strategies resides in the need to ensure a coherent, unitary evolution of the entire localities. [4], [7]

The sustainable development of urban areas can contribute to the creation and development of sustainable and balanced urban areas from an economic, social, cultural and territorial point of view. [9], [10], [11]. As a result, the judicious organization of locality management contributes to ensuring the well-being of the inhabitants, civilized living conditions and, last but not least, harmony between the natural environment and the built space. [12]

2. MATERIAL AND METHOD

Two GNSS STONEX S10A GNSS stations were used as topographic equipment for the realization of the project to determine the coordinates for the starting points and a LEICA TCR 407 station to survey planimetric and altimetric details from the areas that are the subject of the inventory. The data processing was carried out with the help of the computer environment specific to the graphic field by using the programs AutoDESK AutoCAD Raster Design, ArcGIS and last but not least TopoLT. Also, the specific download programs for the topographic tools used were used. [13], [14] The evolution of green spaces at the level of the municipality of Timișoara was analyzed in two distinct steps:

- Field works;
- Office activity.

The field part involved the collection of existing data on the ground: the equipment used to perform G.P.S.-type field measurements. was represented by two G.P.S. receivers. – LEICAs that worked at the same time, connecting to 4 common satellites, to be able to receive information permanently and without interruption, to avoid the risk of jammingFor classical measurements, a LEICA TCR 407 total station was used, with which measurements were made for detail points that make up objects or details that define the relief. Horizontal directions, distances and zenith angles were measured for each detail point in the terrain. They are measured relative to the orientation point and relative to the radiated point.

Timișoara is located in a relief area characterized by a remarkable smoothness of the plain surface, interrupted only by the Bega riverbed, and a series of

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local peculiarities expressed altimetrically by modest unevenness that does not exceed 2-3 m.

The terrain configuration was made based on contour lines.

3. RESULTS AND DISCUSSION

After collecting data from the field, they were calculated in the office and reported in digital format on a plan using classic point interpretation software such as (AutoCAD, ArcGIS).

In addition to these data, cartographic materials existing in the area were also used, overlaying them on top of the data collected from the field. We followed some basic notions in carrying out this complex process, such as:

- scanning;
- digitizing plans and maps;
- plan vector;
- scaling;
- achieving of digital terrain model.

Moving from two-dimensional to three-dimensional representation makes the image closer to the actual appearance. For the municipality of Timișoara, a navigation in three-dimensional space and a correct visualization of the objects was realized. A digital terrain model (D.T.M.) is a generic term for the definition of the topographic surface of the land, in digital format, which contains both altimetric and planimetric information of the topographic surface, which helps in the detailed characterization of the topography of the land. Digital terrain models are a core component of geographic information systems (G.I.S.). [2]. When working in the three-dimensional space, you can choose different perspectives on the created objects, to facilitate their definition and editing, but also to present them in a favorable position.

Achieving the green cadastre

Undoubtedly, every manager of a park or other form of green space must have a documentation on his object of management.

There are sometimes also park establishment projects or restructuring projects along the way. As time passes, the value of the project is reduced to a record of general systematization and endowments.

From the investigations carried out, the level reached in many European countries in this field is that of a basic green cadastre, which boils down to the inventory of the existing species in a park, possibly with their strictly topographical location. The actual management of the parks is done by landscape architects, who are based, however, in the solutions they adopt only on their artistic training, without having at their disposal certain quantified structural aspects. Their management thus remains at a strictly artistic level, without scientific rigor.[1]

The method of Timișoara's green spaces system aims to combine the two essential aspects in the development and harmonization of a green space, namely it allows the overlap of this green cadastre over the management of green spaces itself. Thus, it is proposed to carry out an inventory of both the trees and shrubs as well as the entire woody vegetation in a park.[8]. The structure of this inventory is based on two components: Spatial Inventory and Qualitative Inventory.

Spatial inventory aims to plan all trees and shrubs and notify them both on the plan and physically in the field.

This is done as follows:

- The plans made through the urban cadastre are used, which contain the network of alleys and a series of objectives / constructions in the park;
- A traverse is made, having points of knowing coordinates at the starting point and at the ending point, and all elements (trees, bushes, objects, constructions, etc.) are measured by surveying with the total station;
- On the computer, after calculating the coordinates of each measured element, they are transferred to a plane with the current number associated with each element.
- For the most complete endowment of the plan, each copy is made with a geometric symbol (circle, octagon), in the center of which the inventory number will be written.
- The Circle or Octagon that is represented on the scale plan renders the projection of the crown of the tree using different colors for coniferous or deciduous.

Qualitative inventory it is based on a broad and accurate characterization of each specimen with elements necessary for the implementation of the green cadastre, at the end of which the value of each tree or shrub will be determined.

It begins with the collection and processing of data characteristic of the trees. This step is based on entering some data, both physical characterization elements and functions.

- For easier data processing on the computer, all species were coded, namely two coding systems were used:
  - Numeric (simpler);
  - Alphanumeric (more complex).

The next step includes the allocation of each species in a certain category, which helps to form the structure of a green space: trees, shrubs, deciduous, resinous.

Then the age of the tree or shrub must be specified, a difficult element to establish in the absence of historical data. Finding the age can be done with precision, taking into account the thickness of the trunk and the growth characteristic of the species.

After completing the inventory of the characteristic elements, the position occupied by each specimen in the structure of the park is specified. Two main aspects are considered: the position of the specimen and the dominance of the crown.

The first element, the position of the specimen, establishes the horizontal structure of the park, and the dominance of the crown is present in the horizontal as well as in the vertical structure, both of which together compose the two main characteristics.

Together with the determination of the crown volume of trees and shrubs, the ecological function is established. The volume is determined by the diameter of the crown which shows by default and the

projection surface on the ground and the height of the crown which is determined by certain offsets.

It was necessary to implement a new indicator, namely the global value of the specimens. This value has a practical importance, being used as a recovery value in case of penalties applied for the destruction of trees and is determined as follows:

VGL=VAE*VIT*VPE

where: VGL= global value;
VAE= ecological value;
VIT = vitality;
VPE= landscape value.

The field data collection stage is possible with the help of 28 elements. All these data are for reference, the data that will be collected later, over time, will be related to them. By processing this data can obtain:

- A plan of the park at different scales;
- Highlighting tree species by category;
- Evidence of the number of specimens and the projection surface of the crowns;
- Establishing the number of specimens per hectare;
- The percentage of space occupied by crowns;
- Establishing the thickness of the "ecological layer", resulting by dividing the total standard volume by the entire surface;
- Establishing the vertical structure of the park, expressed by the distribution of the real volume of crowns by height classes;
- Average landscape value, per number of copies;
- Average global value per number of copies;
- The record of the facilities in the park (alley density m²/ha, the density of the banks nr/ha), other facilities (lighting, water mirrors, ornamental works, etc.).
- Visitor capacity, current and optimal;

All these definite, quantified data regarding the condition and structure of the vegetation and the facilities in a park constitute the essential component of substantiating the management of a green space.

The existing situation of green spaces in Timișoara

The municipality of Timișoara currently has 510 ha of public green spaces of which: parks 117.57 ha, squares 21.58 ha, green spaces from street alignments and blocks 290.15 ha, forest cover 30 ha and Green Forest 50.7 ha. (Table 1) and (Figure 4).

The share of green spaces in the total area of the neighborhoods **Table 1**

Nr	District	Terrain surface (m²)	Green area surface (m²)	Percentage
1	Cetate	1.001.848	520.629	52%
2	Fabric	1.829.186	827.754	45%
3	Elisabetin	1.755.884	674.582	38%
4	Iosefin	725.412	256.455	35%
5	Mehala	1.052.783	490.673	48%
6	Fratelia	455.663	176.651	39%
7	Freidorf	240.438	105.237	44%
8	Plopi	143.834	52.882	37%
9	Ghiroda Noua	145.880	46.600	32%
10	Ciarda Roșie	219.028	94.305	43%

Apart from public green spaces, in Timișoara there are also a number of private spaces designed as private gardens.

Exceptions to the monitoring of green spaces:

- those with limited use - inside businesses and institutions, educational institutions, sports fields, playgrounds, individual gardens, etc.;
- those with special purpose - around monuments, those intended for sanitary protection, cemeteries, botanical gardens, zoological gardens, etc.

Parks represent large units of green space that must ensure passive and active rest for the residents of urban centers. They are becoming a must for cities with over 50,000 inhabitants. Vegetation in parks must have a main weight, namely 65-75% of the total area, distributed as follows: 30-60% tree and shrub plantations, 35-65% grassy area, 3-5% flower plantations. [3]

At the level of the municipality of Timișoara, the surface of the parks is 117.57 ha, and that of the squares is 21.58 ha. (Table 2).

From the point of view of the distribution of parks on the territory of the municipality of Timișoara, there is a concentration of parks in the central area of the city. The series of parks is predominantly located on the northern bank of the Bega River. Compared to this advantageous area, the city also has two larger parks in the south-east (Stadium Park and Lidia Park).

From the perspective of planning parks and squares, the component areas can be divided into the following categories:

- land with grass and flowers;
- alley;
- flower beds;
- other covered lands;
- water mirrors.

Figure 1. Park of Roses, Timișoara

Green spaces in street areas and in areas of residential units improves architectural ensembles, improving the local microclimate through shading, absorption of noise, dust and other atmospheric pollutants specific to the urban environment. The area of green spaces in the areas of residential units is 272.39 ha.

Regarding the green spaces in the street areas, the street alignments that are made up of tree, shrub and flower plantations are noteworthy and fulfill a number of important roles:

• connect parks, squares and other green spaces;
• reduce wind speed, sunstroke risk, noise level;
• increase the relative humidity of the air, enrich the air with oxygen and reduce carbon dioxide;
• constitutes a bacterial filter (it emits phytocides that kill microbes);
• gives an aesthetic aspect to the streets.

At the level of the municipality of Timișoara, the main boulevards are lined with one or two rows of trees. The area of green area related to the main boulevards in Timișoara is 17.76 ha. (Table 2).

Regarding the layout of the spaces in front of the buildings, three stages can be noted, namely: In the old housing estates there are old trees and shrubs, distinctive, but which have not been cared for properly for a long time, as well as the green spaces are no longer maintained (uncut grass); In front of the buildings in the new housing estates, the space allocated to the green area is very little. In these neighborhoods, instead, you can admire special landscaping inside the property, real dendrological parks, with state-of-the-art facilities;

In the neighborhoods of blocks of flats, the green space is generous, in some neighborhoods there are playgrounds and rest areas.

In Timișoara, blocks of flats are grouped in groups of three or more, forming between them a square with green space. Some of these green spaces have been redeveloped with garage batteries, and others have been reclaimed by the old owners.

Surfaces of public street green spaces and those in residential areas

Table 2

District	Total surface of district (ha)	Estimated surface of the garden	Occupancy rate (%)
Cetate	307.6	17.1	6
Fabric (A)	440.2	84.6	19
Fabric (B)	243.0	50.9	21
Elisabetin	642.9	171.9	27
Iosefin	321.8	96.4	30
Mehala	445.8	194.9	44
Fratelia	226.4	105.0	46
Freidorf	118.4	54.1	46
Plopi	72.0	34.6	49
Ghiroda nouă	81.9	40.4	49
Ciarda roșie	95.9	43.3	45
Total	2995.9	893.2	30

Ecological parking lots it is delimited from the sidewalks by planting a hedge or a line of trees associated with the hedge, depending on the width of the green space (Figure 2).

Creating ecological parking lots has the following advantages:

- providing a parking space;
- improving the quality of water and air through the uptake of pollutants by vegetation;

Figure 2. Ecological parking

- reducing exposure to UV radiation (in the case of ecological car parks with trees and heat islands;
- improving the aesthetic appearance.

Private gardens within individual households constitute a separate category of green spaces, their surface not being accurately inventoried, but only estimated at the level of each neighborhood, based on a study of the cadastral sheets of the municipality (Table 3.).

Estimated areas of private gardens in the municipality of Timișoara, distributed by districts

Table 3

District	Total surface of the district (ha)	Estimated surface of gardens	Occupancy rate (%)
Cetate	307.6	17.1	6
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The Green Forest, located in the north-east of Timisoara, is a forest beach with an area of approx. 724 ha, systematically laid out in 15 ha squares. The forest belongs to the city of Timișoara, but it is not properly arranged to be considered a forest - park. However, there are a number of objectives set up, such as: the Forestry School Group, the anti-communist Resistance monument in Banat, the Village Museum and the Zoo. [2], [3].

The main functions of the Green Forest are ecological and recreational. The priority function is the ecological one, of climatic balancing of the area. The exclusion of the main cuts for almost 40 years led to the aging of the stands, to an increase in the volume of the crowns and, implicitly, to an increase in the ecological effect.

From the cartographic data from the period 1723-1725 and 1776, it follows that there is forest in the area where the Green Forest is located.

Figure 3. Timisoara Green Forest

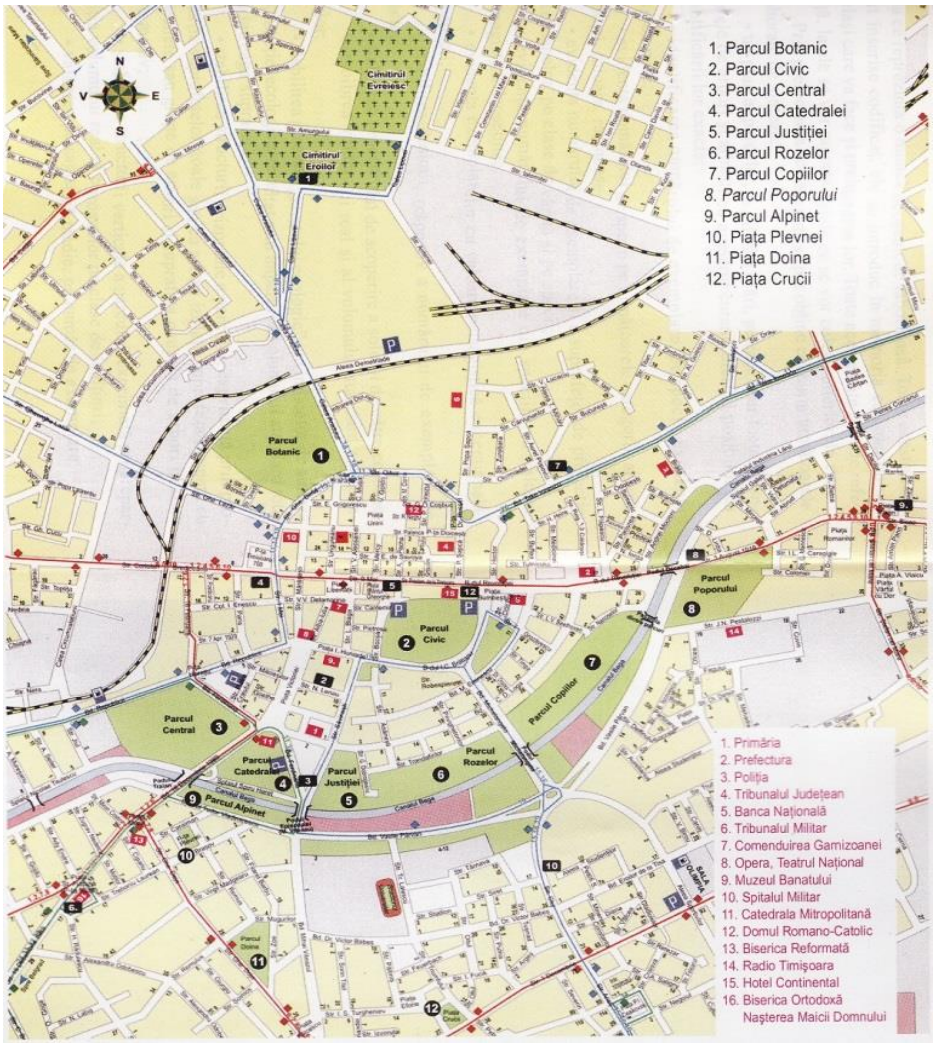

Figure 4. Green spaces in the municipality of Timisoara

The forest area at that time was much larger, stretching over the commune of Dumbrăvița. In the 19th century, a large part of this forest was cleared and the commune of Dumbrăvița was established. The current Green Forest has an artificial character. The first landscaping took place in 1860 and was carried out by the Hungarian Forestry Service, followed by two other landscaping in 1894 and 1908. In 1947 it was landscaped by the Arad Forestry Directorate and included in the Timișoara Forest Park, a hunting park (Figure 3).

The forest is traversed for a length of 2.6 km by the Behela stream (a tributary of the Bega Canal), which feeds Dumbrăvița lake before entering the forest.

4. CONCLUSIONS

In order to achieve a sustainable development, a very important role must be given to the environment. Thus, in order to follow the steps described above, we reach a very important component, but unfortunately many have ignored it until now, the green cadastre. It appeared as a necessity to expand and detail the urban cadastre, with the object of the inventory being all the vegetation, both that in the urban green spaces delimited as such, and that located on the street network or even in the premises of institutions, businesses and homes. The present paper describes the implementation of the green cadastre in the municipality of Timișoara. The westernization of the municipality is obvious considering that it is the only one in the country where this system has been implemented, in addition thus finding that Timișoara has the best ratio of green space/inhabitants.

The municipality of Timișoara currently has 510 ha of public green spaces (Figure 4), of which: parks 117.57 ha, squares 21.58 ha, green spaces from street alignments and blocks 290.15 ha, forest cover 30 ha and the Green Forest 50.7 ha.

In conclusion, the municipality of Timișoara is a strong community due to its accessibility, innovative and entrepreneurial economy, strong partnership with the community, and last but not least due to the quality and attractiveness of the environment.

However, in order to become a strong community at the European level, it is essential to strictly follow the steps imposed by a sustainable urban development.

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