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Using GIS Analysis to Assess Urban Green Space in Terms of Real Estate Development

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RESEARCH ARTICLE

Abstract

Urban green spaces (UGS) contribute to the development of the ecosystem, especially in crowded urban areas such as cooling effect, air and noise pollution mitigation, recreation, aesthetic pleasure, quality of life and public health, as well as economic benefits, such as raising the price of the real state in the vicinity of UGS. The aim of the paper is to realize a study on green spaces and an urban distribution of the size of a systematic planning of functional and aesthetic qualities. This study examines the distribution and amount of green space, as well as the size and rates per capita are assessed. Even the distribution of distance and the accessibility of green areas throughout the city are closely linked to ensuring recreational needs. Spatial statistics using GIS have made possible the development of correct, coherent explanatory UGS variables such as distance, size, density, connectivity, sight and accessibility. The parks and all green spaces composed of polygons were digitized from the ArcGIS Attribute Table for the evaluation of per capita rates and the execution of a plan to combat the deficit of green spaces. In order to make an assessment of the green spaces, a comparative study of the area of interest from 2010 and 2020 was considered. According to the spatial analyses from ArcGis, during the 10 years, an intense real estate market was developed, affecting the distribution of green spaces per capita.

Keywords: GIS; green space; development.

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INTRODUCTION

Rapid urbanization and development of the business environment have caused serious problems of land use placement causing serious damage to the environment, climate change, the effect of the urban lifestyle on the health, physical and psychological condition of people living in cities, researching open green spaces in urban areas is more vital than ever. (Badea, 2013; Păunescu et al., 2017).

This paper aims to analyze the development of urbanization over 10 years. It will also analyze how this development has affected the environment of green spaces. For this we will choose the Manastur neighborhood from Cluj-Napoca locality, Cluj county, Romania. Ensuring the surface of green space per capita is a challenge for almost all cities in Romania, especially in the condition of chaotic urban development since the fall of the communist regime (Droj, 2016; Șchiopu, 2007). Also, during the communist regime, the urban regulations, respectively the surface of the green space per capita did not necessarily represent a very important problem, and after the fall of this regime, for several years the urban regulations were not taken into account at all.

MATERIALS AND METHODS

The development of UAV technology, but also of the calculation technique from the last period allows the realization of complex studies based on photogrammetric surveys. In this article, the aim was, among other things, to inventory the surface of green spaces using UAV photogrammetric technology. In this sense, the UAV photogrammetric surveys were carried out on an area of about 402 ha covering the Mănăștur and Plopilor neighborhoods. A number of 2652 frames were taken from an average altitude of 111 m.

Following the photogrammetric processing, an orthophotoplan with an average natural resolution of 2.7 cm/pix was obtained. The aim was to ensure a degree of lateral overlap between frames of at least 70% and a frontal overlap of at least 80%.

In order to georeference the orthophotoplan, the 3D model and the point cloud, a number of 33 ground control points were determined, evenly distributed over the entire surface as show in Figure 1.

The coordinates of the ground control points were taken with a Trimble R8S GNSS receiver. At the same time, in addition to the ground control points, a number of four checkpoints were measured. The mean square errors at the ground control points were 0.026 m planimetric and 0.008 m altimetric, and the mean square errors at the checkpoints ranged between 0.061 m planimetric and 0.099 m altimetric.

The main deliverable was represented by the orthophotoplan, but in addition to this, a digital elevation model of the studied area was obtained, which can be seen in Figure 2.

Figure 1. GCP locations

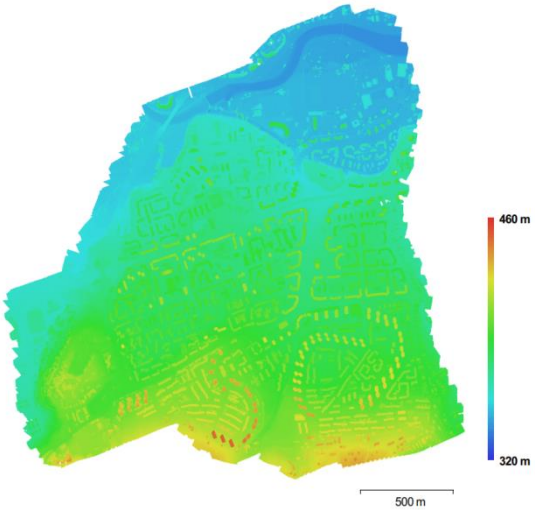

Figure 2. Reconstructed digital elevation model

The Raster Calculator tool allows you to create and execute a Map Algebra expression that will output a raster.

In order to establish the surface of the green spaces, but also to compare these green spaces with historical data, two raster images were used. Figure 3 shows an orthophotoplan of the area studied since 2010, and Figure 4 shows the orthophotoplan obtained by UAV photogrammetric methods in 2020. The raster computer tool was used to automate the identification of changes, respectively the construction of overbuilt buildings above the green spaces. (https://developers.arcgis.com/labs/)

The Raster Calculator tool is specifically designed to offer the following benefits:

- Implement single-line algebraic expressions.
- Support the use of variables in Map Algebra when in ModelBuilder.
- Apply Spatial Analyst operators on three or more inputs in a single expression.
- Use multiple Spatial Analyst tools in a single expression.

Raster Calculator is designed to execute a single-line algebraic expression using multiple tools and operators. When multiple tools or operators are used in one expression, the performance of this equation will generally be faster than executing each of the operators or tools individually. (https://doc.arcgis.com/en/arcgis-online/reference/search.htm).

Figure 3. Ortophotomap 2010

Figure 4. Ortophotomap 2020

RESULTS AND DISCUSSION

As can be seen in Figure 5, respectively Figure 6, we can visually identify the changes, respectively the overbuildings that appeared above some green spaces.

Figure 5. Ortophotomap 2010 green areas

Figure 6. Ortophotomap 2020 overbuildings

In order to validate these changes, but also to validate the results provided by the computer raster tool, we used to subtract the two raster images, as can be seen in Figure 7.

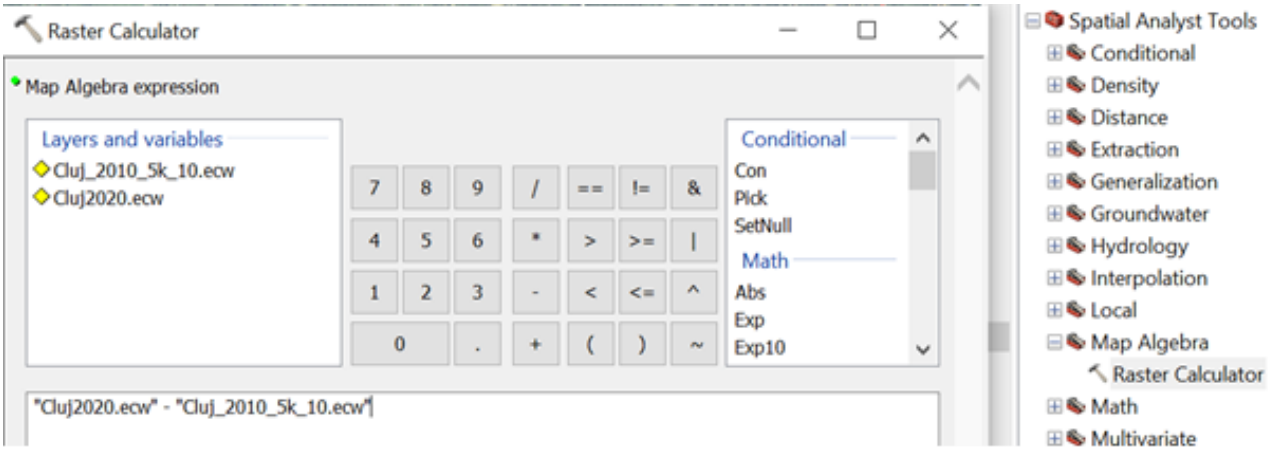

Figure 7. Raster calculator tool in ArcMap

The results obtained using the raster computer tool are presented in Figure 8. As can be seen in the same figure, the areas that have undergone changes are colored red, and the areas that have remained unchanged are colored

green. It can also be seen that shaded areas are identified as changes, which is an error. For a more detailed analysis of changes would have been preferable to use data without shading, but these were not available for the period 2010.

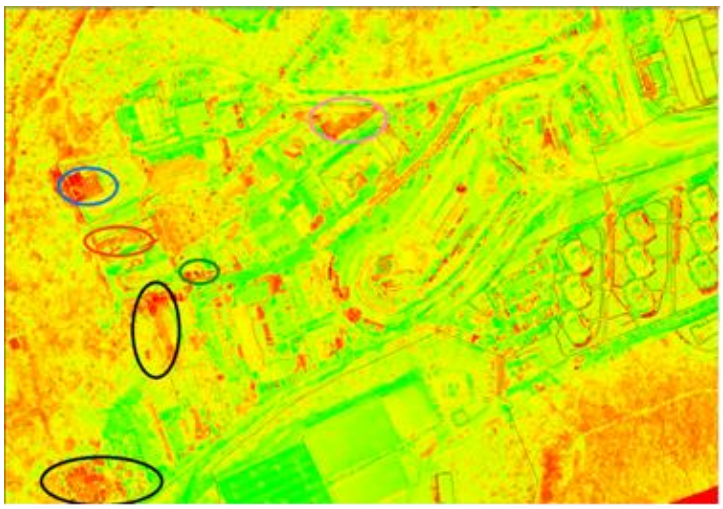

Figure 8. Detected changes using raster calculator tool

The surface of the area of interest is approximately 206 ha, of which the surface of green spaces is about 56.9 ha, representing a percentage of 27.62% of the total studied area. If we consider a population of about 120,000 inhabitants of the Manastur neighborhood, the area of green stations per capita would be about 4.74 sqm.

Considering that the norm of the World Health Organization is 50 sqm / inhabitant for the green space, and the standards of the European Union refer to 26 sqm/ inhabitant, it can easily be concluded that the Manastur neighborhood is overcrowded and does not comply with space standards. green per capita. Of course, the analysis is made on the central area of the neighborhood, and if the analysis were extended to include Colina Park (about 14.6 ha) and Faget Forest (about 150 ha), the area of green space per capita would be about 18.46 sqm.

In order to better monitor the urbanization of the neighborhood, a web page (Figure 9) was created to facilitate the re-packaging of the plans of the green spaces, of the buildings, of the recreation areas, etc.

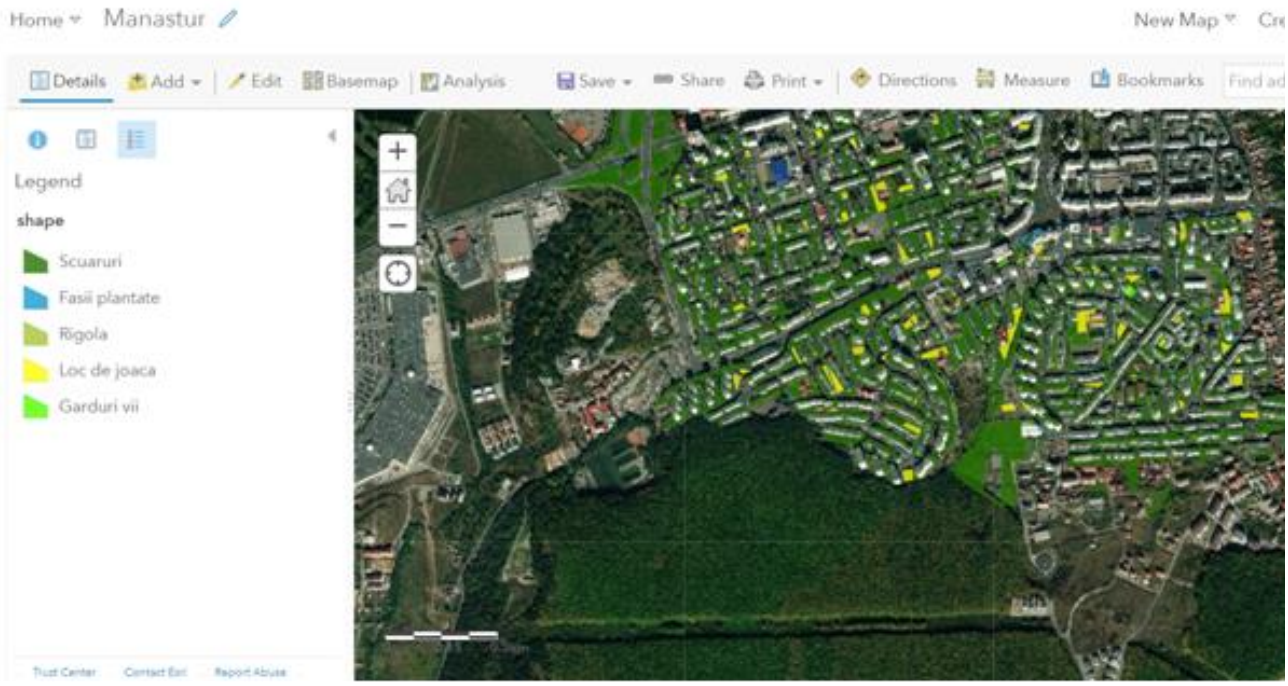

Figure 9. ArcGis Online page

CONCLUSIONS

Using UAV photogrammetric technology, large areas can be mapped in a very short time, and with little effort. The precision of UAV photogrammetric products allows the inventory of green spaces with increased precision. By performing spatial analyzes using ArcMap applications, the changes in certain areas can be automatically identified, without having to vectorize all the data, being possible the analysis strictly on raster data.

The web maps offer the possibility to visualize the characteristics of each domain as well as to the respective analyzes of the spatial data filters in order to optimize the necessary conditions to ensure a good health of the inhabitants.

Based on the analyzes performed in this research, numerous problems were identified, such as the decrease of the green space surface by over-buildings, non-compliance with the international and European norms regarding the minimum green space surface per capita, etc. All these identified problems require a good management of green spaces by the specialized departments within the local public administration, but also by real estate investors.

Author Contributions: I.C.., T.S. and I.D.P. conceived and designed the analysis; M.E.N., J.D., S.C., I.L. and D.F. collected the data; T.S., I.D.P. and F.M. contributed data or analysis tools; I.C., T.S., S.C. and E.E.Ş. performed the analysis; I.C., M.E.N. and T.S. wrote the paper.

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Conflicts of Interest

The authors declare that they do not have any conflict of interest.

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