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METHODS FOR IDENTIFYING THE BENEFITS ASSOCIATED WITH URBAN GREEN INFRASTRUCTURE AT DIFFERENT URBAN SCALES

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Abstract: In the context of increased urbanization, urban green infrastructure (UGI) is an important tool for preserving the structure and functions of natural ecosystems and providing diverse benefits to the human population. The study of benefits is of high importance for the spatial and administrative planning of urban green infrastructures. The present analysis aims to understand the benefits associated with green infrastructures and to develop new possibilities for integrating green infrastructures into urban planning, using the municipality of Buzău as case study. In order to assess the distribution of UGIs in Buzău and to identify the benefits and services associated with them, 227 questionnaires were applied to local population. The case studies offer the possibility to provide concrete examples of current urban green infrastructures management practices. For the municipality of Buzău, the most desired elements of green infrastructure in the city is: parks and public gardens (94.20%), outdoor sports facilities (84.58%), street alignments (79.29%) and flower arrangements (55.06%). The involvement of the local community in the UGI planning process is a strong point, which should be integrated in the practices of local authorities and implemented effectively.

Key-words: urban green infrastructures, ecosystem services, multifunctionality, Buzău, urban planning

1. INTRODUCTION

Over the last century, urban areas represented a major contribution to global warming, while being particularly vulnerable to the effects of climate change and extreme events (Kammen & Sunter, 2016). Urban transformation has lead to the emergence of several environmental problems, such as the loss of open green spaces, increased road traffic and energy consumption (Cho & Choi, 2014).

As the world's population increasingly becomes urban, challenges such as maintaining a high quality of life and adapting to climate change arise. The concept of urban green infrastructure (UGI) has become a priority in urban policies (Davies & Lafortezza, 2017). In the context of increased urbanisation, UGI is an important tool for preserving the structure and functions of natural and semi-natural ecosystems (Aronson, et al., 2017) and providing providing a wide range of benefits to the human population.

The concept of green infrastructure is a relatively recent one in terms of terminology, but not in terms of principles. It has its origins in the spatial planning and approaches for biodiversity conservation that characterized the United States of America in the 19th century (Niță, 2016). UGIs are identified as valuable tools for meeting the needs of ecological conservation and environmental protection (Naumann, 2011), while representing an important element for social sustainability (Badiu, 2016).

Urban green infrastructure provides direct and indirect benefits to human health and well-being, often

expressed through the concept of ecosystem services (Jennings, et al., 2016). According to the European Commission, the Earth's ecosystems provide humanity with a wide variety of benefits, known as *ecosystem goods and services* (European Commission, 2009). Ecosystem services fall into several broad categories, based on different research projects or assessments of the state of the environment by experts, e.g. MEA 2005, TEEB 2010, MAES 2013, 2014, CICES 2013, etc. These are: productive services, regulating services, supporting services and cultural services. Several researchers use the concept of *services* synonymously with ecosystem benefits (Millennium Ecosystem Assessment, 2005), while others argue that outputs should not be classified as services unless they generate *benefits* valued by society (Jennings, et al., 2016).

Urban green infrastructures are of high importance in cities due to their wide range of potential benefits, such as: improving air quality by filtering pollutants (Bolund & Hunhammar, 1999), mitigating the urban heat island, reducing energy demand, increasing recreational opportunities (Winters et al., 2012), preserving and restoring habitats (Fahrig 2001), reducing noise levels, controlling stormwater run-off and minimizing the effects of flooding.

Under defficient management, UGI can also generate environmental problems and actually deliver disservices instead of benefits. Among the most known are the dispersion of pathogens, allergenic plants, pests and the occurrence of diseases caused by the fauna and flora present in green infrastructures (Lyytimäki et al., 2008, Niță et al., 2014).

In recent years, many studies have developed methods for quantifying and evaluating the benefits of UGI (Derkzen et al., 2015). At the same time, a number of authors note an inconsistency of methods used to quantify ecosystem services (Adamescu, et al., 2016). Mapping, modelling and valuation of ecosystem services are essential to integrate the concept of ecosystem services into urban planning and decision making (Kremer et al., 2015). Methods to assess the benefits associated with UGI include among others: multi-criteria analysis (Kremer et al., 2015), DELPHI method, use of quantitative indicators (Derkzen et al., 2015), analytical ranking, mapping, participatory approach.

Common approaches to mapping green infrastructure in urbanized environments focus on associating land use or land cover with functional or physical features (Dennis, et al., 2018). Mapping allows the identification of UGI typologies and distribution and the relationship between the human community and potential ecosystem services associated with green spaces. By mapping and identifying typologies of urban green infrastructures, it is possible to identify locally non-functional areas, abandoned land, on which new functional green spaces could be integrated.

The identification and assessment of the importance of ecosystem services must take into account the particularities of local communities, so the participatory approach in as essing the benefits of UGI is an important approach (Adamescu, et al., 2016). Local people's perception can be a representative source of information that can be used in specific development strategies for UGI (Kalfas et al., 2020).

An integrated approach to the planning, monitoring, design and maintenance of urban green infrastructures is needed to improve environmental sustainability in cities at different urban scales (Haq, 2015). Integrating ecosystem services associated with UGI into urban planning would result in social, economic and environmental success (Niemela, et al., 2010). The results of assessment methods could be used in development strategies, green register updates, plans and projects at local, national or regional level.

The current paper aims to assess the distribution of UGIs in Buzău municipality at different urban scales and to identify their benefits/services, as these are important steps in identifying the potential of green infrastructure development for Buzău municipality. Following the preliminary studies on UGIs, the research hypothesis is based on the need to integrate green infrastructures into urban spatial planning. The research question was: To what extent can the information obtained from residents help in the process of integrating green infrastructures in the urban planning of Buzău at different urban scales?

2. METHODOLOGY

2.1. Study area

Buzău is the municipality of the county of the same name, located in Muntenia, Romania (Buzău City Hall, 2015), with 129,085 inhabitants at the 2021 census (National Institute of Statistics, 2021). The city is located on the right bank of the Buzău River, right at its exit from the curving subcarpathian hills, in a region with a temperate climate.

In the north and north-west the area is covered by hills with heights between 500 and 700 m, and in the north-east the Piedmont plain slopes gently down from north to south. In the eastern part of the city lies the Buzău River Plain and in the south lies the Buzăului Plain, with agriculturally productive land (Buzău City Hall, 2014) (Fig. 1).

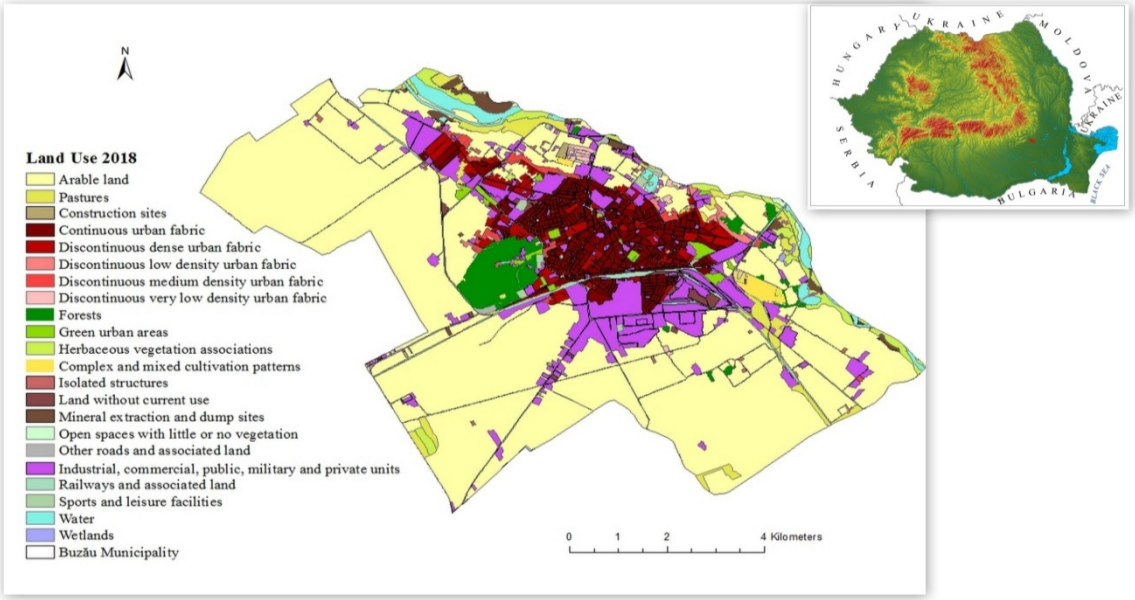

Figure 1. Location and land use for municipality of Buzău. Data source: Urban Atlas 2018 - Copernicus Land

2.2. Data collection

Data related to green infrastructure and urban planning specific to Buzău municipality were taken from several sources. Data on the Crâng Park and forest were provided by the Buzău Forestry Office, from which information was obtained on the Crâng forest, existing tree species, plant species, animals, soil type, etc. For the protected natural area ROSCI0103 Lunca Buzăului, data on habitats and species for which it was declared a protected natural area were taken from the Management Plan approved by the Order of the Minister of Environment, Water and Forests no. 1075/ 2016.

Among the tools used in the analysis, provided by the local authorities, there is the Green Spaces Register, belonging to the Buzău City Hall, which is a documentation that is drawn up to highlight the green spaces in a territory, constituted as a GIS information system. It was also used to identify the surface areas of the categories of green spaces.

The maps illustrating the distribution of green infrastructure categories in Buzău municipality were made using: Urban Atlas 2018, Green Spaces Register and Corine Land Cover (CLC) 2018, 1990. Urban Atlas 2018 provides high-resolution land use and land cover data, which can be downloaded for free and used in various analyzes (Copernicus Land Monitoring Service, 2021). To use the data, they were re-projected to Stereo 1970. The land use map for the municipality of Buzau, according to Urban Atlas 2018 data, is illustrated in Figure 1. The software used in the analysis are: Arc Map 10.6.1, QGIS Desktop 3.6.1.

2.3. Data analysis and representation methods

Regarding the theoretical research, descriptive, comparative, quantitative and qualitative analysis, geographical explanation was carried out. The methodological workflow is shown in Figure 2. In order to evaluate the perception of the inhabitants on the quality and importance of the urban infrastructures in Buzău, a questionnaire was applied online between 21.08.2019 - 13.04.2020 and 31.08.2021 – 22.09.2021. In the analysis we evaluated the perception of 227 people living in Buzău. The questionnaire consists of several sections, which aim in a logical sequence: knowledge of the notion of UGI and specific typologies present in Buzău, quantification of benefits or services induced by UGI in Buzău, idealization of ecosystem services associated with them, identification of the main problems generated by green infrastructure, information on current management and planning of green infrastructure and the role of green infrastructure in combating environmental problems faced by the municipality of Buzău.

The perception of the inhabitants for the urban green infrastructures highlights similarities, but also some contradictory aspects, which appear most obviously between the different age groups. The interviewees belong mostly to the young and adult age groups (15-64 years), in number of 220 people and from the ageing group (over 64 years) 7 people were interviewed. Applying the online questionnaire led to an increase in the number of respondents in the young and adult groups in providing answers. The online questionnaire was answered by 102 males and 125 females (Fig. 3).

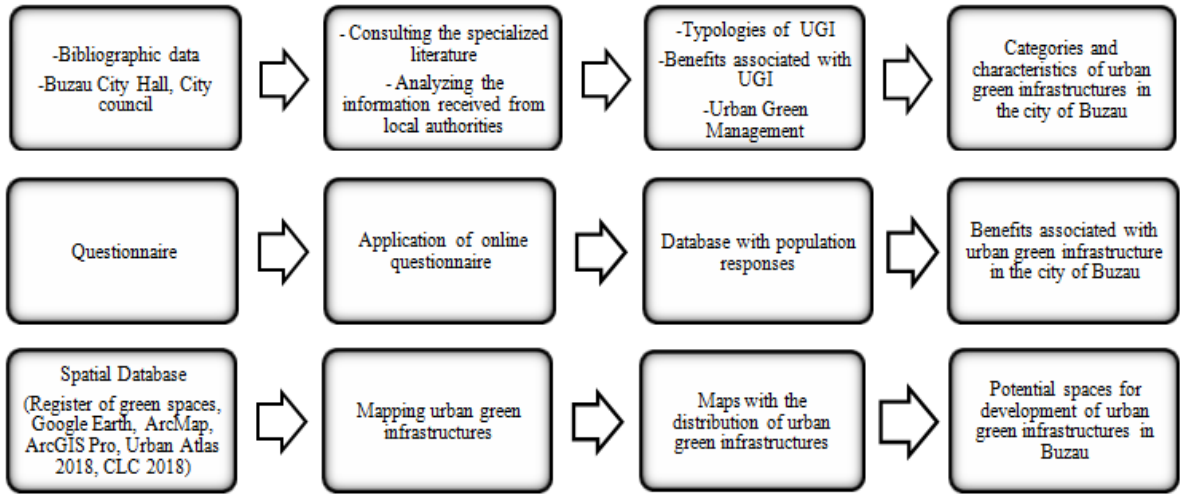

Figure 2. Methodological workflow of the analysis

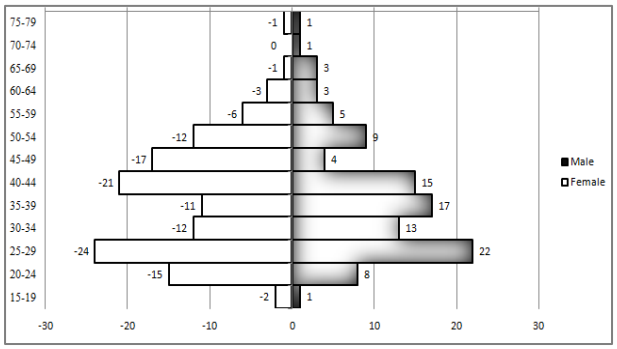

Figure 3. Age structure and gender structure of the respondents

The approach for integrating UGIs in the urban planning of Buzău municipality involved the identification of non-functional, disused spaces in Buzău municipality on which new green spaces could be integrated. The case study carried out for the Post Office District in Buzău started from the lack of green spaces in this area. An important aspect was also the desire of the inhabitants of the Post Office district to develop new green spaces.

3. RESULTS

3.1. Types and distribution of UGIs in Buzău municipality

Table 1 shows the distribution of the current situation of the UGI categories in Buzău municipality, according to the Register of Green Spaces of Buzau municipality and the city mapping. Areas were calculated for each UGI category in the ArcMap program.

By using data on the types of green spaces and their location, maps with the distribution of UGI categories in Buzău municipality were produced. The following types of UGI were identified: parks, street alignments, urban forests, gardens, playgrounds, green spaces in public and private institutions, cemeteries, natural or antopic wetlands, agricultural land. The identification and location of UGIs can be used in the updating of the Green Spaces Register of Buzău municipality. In Buzău there are 3 main parks (Fig. 4): Crâng Park, which is considered the most important and most beautiful park of the city due to the association park-forest, Tineret Park and Marghiloman Park. In Buzău, the street alignments are located in the central areas of the city, especially on the main boulevards and at some of the intersections of important streets there are squares. Also, protective street alignments have been identified in the South Industrial Zone of Buzău.

Crâng Forest is the only forest resource of Buzău municipality, having a special importance for Buzău inhabitants. It occupies 1.82 .km^2 of the total area of 81.3 km^2 of Buzău. The urban forest combines biodiversity conservation objectives with social objectives, while generating a whole range of ecosystem services.

In the city of Buzău, the Crâng Forest is the only type of forest vegetation that constitutes a specific natural habitat for certain species of plants and animals, compared to the other existing vegetation types (Fig. 1). Thirty-one playgrounds were identified (Fig. 5) related to parks and residential neighbourhoods and four public cemeteries, namely Dumbrava Cemetery, Heroes' Cemetery, Saint George's Cemetery and Saints Constantine and Helena Cemetery (Fig. 6). Besides these, there are 4 parish cemeteries, 2 private cemeteries, a military cemetery, a Catholic cemetery and a Jewish cemetery. In Buzău municipality there are only gardens related to collective and individual residential spaces, of medium or small sizes. The gardens of collective residential areas in the city of Buzău consist mainly of lawns, flowering plants and shrubs.

Table 1. Current situation of UGI categories in Buzău municipality

Category of urban green areas in Buzău City	Number	Area (ha)	Land suitable for recreation ha / built area (1049 ha)
Parks	Main parks - 3 Small parks - 6	38.54 6.52	0.042
Street alignments	Tree alignment - 59 Grassy alignment - 4 Alignment with flowers - 7 Alignment with bush - 10 Isolated trees - 12 Square with flowers - 3 Grassy square - 3	0.5463 0.3756	0.00087
Urban forests	1	179	0.17
Residential gardens	879	20.25	0.019
Playgrounds	31	0.4652	0.00044
Institution and industrial gardens	82	21.77	0.0207
Cemeteries	Public cemeteries - 4 Parish cemeteries - 4 Private cemeteries -2 Military cemetery - 1 Catholic cemetery - 1 Jewish cemetery - 1	22.45	0.021
		SUM: 289.91 ha	
Wetlands	Natural area - 1 Anthropic lakes - 3	311 10.89	-
Agricultural land	Arable land Orchards Vineyards	4597 57 85	-

ROSCI0103 Lunca Buzăului protected natural area is located in the north-eastern part of Buzău municipality (Fig. 7), covering only 6% of the total area of the protected natural area. For the natural setting of Buzău, the river meadow area represents a real wealth. The vegetation specific to this area is of particular importance, due to its role as protection against flooding and as a habitat for certain species of community importance.

3.2. Evaluation of the inhabitants' perception on the benefits of green infrastructures in Buzău municipality

The results of the questionnaire are useful for identifying UGI problems, planning and especially promoting associated benefits. The questionnaire aims to assess the perception of the inhabitants regarding the quality of UGIs in the city of Buzău, the benefits or services induced, their management and specific problems. Figure 8 shows the answers of the residents interviewed regarding the categories of UGI necessary and useful for the municipality of Buzău.

In the next section of the questionnaire, we analysed to what extent UGI influences the quality-of-life components, as perceived by the inhabitants of Buzău. Green infrastructure elements have a beneficial impact on citizens and the community in physical, psychological, emotional and socio-economic terms (European Commission, 2013). The questionnaire addressed the following quality of life components: education, recreational spaces, housing conditions, quality of environment components (Fig. 9). The answers related to the deficiencies in the management and/or planning of UGI in the city of Buzău are illustrated in the following graph (Fig. 10).

3.3. Integration of UGIs in the urban planning of Buzău municipality at different scales

In Buzău municipality there is a potential in the development of UGIs, as a proof of the activities carried out in the last years and of the projects that are being considered by the local authorities in the next period. As regards the development of new categories of green infrastructure, it is necessary to identify some non-functional areas, abandoned land in the city, on which they can be integrated. In addition to the areas that are in the City Hall's sights, which involve the conversion of non-productive and non- functional land into functional spaces and green spaces, there are other areas in the municipality of Buzău that can serve as green space, for example the Poștă district (Fig. 11).

Figure 4. The main parks of Buzău

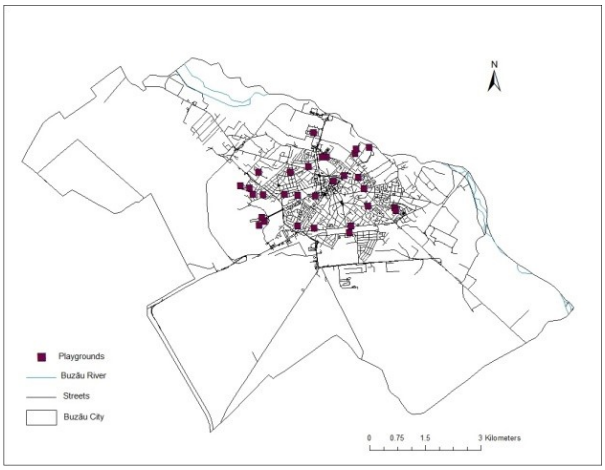

Figure 5. Playgrounds in Buzău municipality

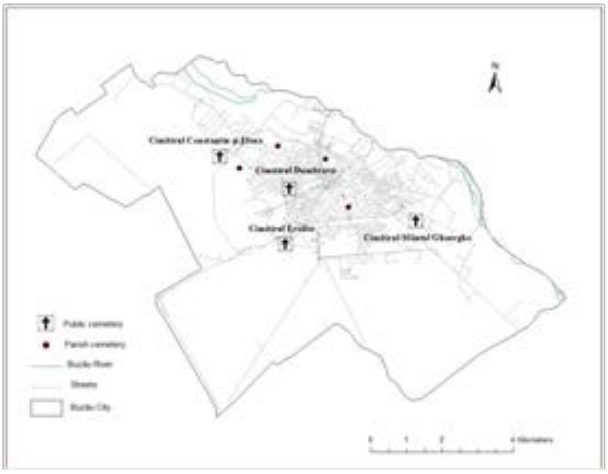

Figure 6. Public cemeteries in Buzău municipality

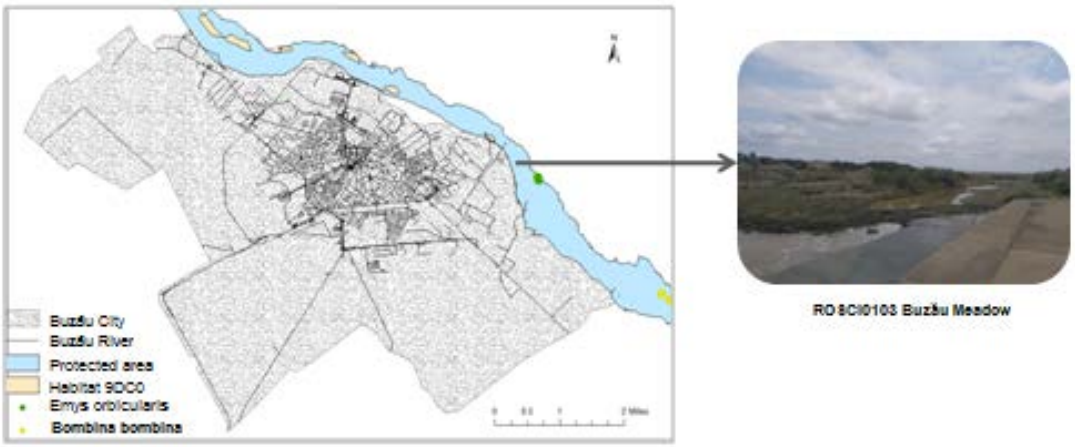

Figure 7. Location of the protected natural area ROSCI0103 Lunca Buzăului

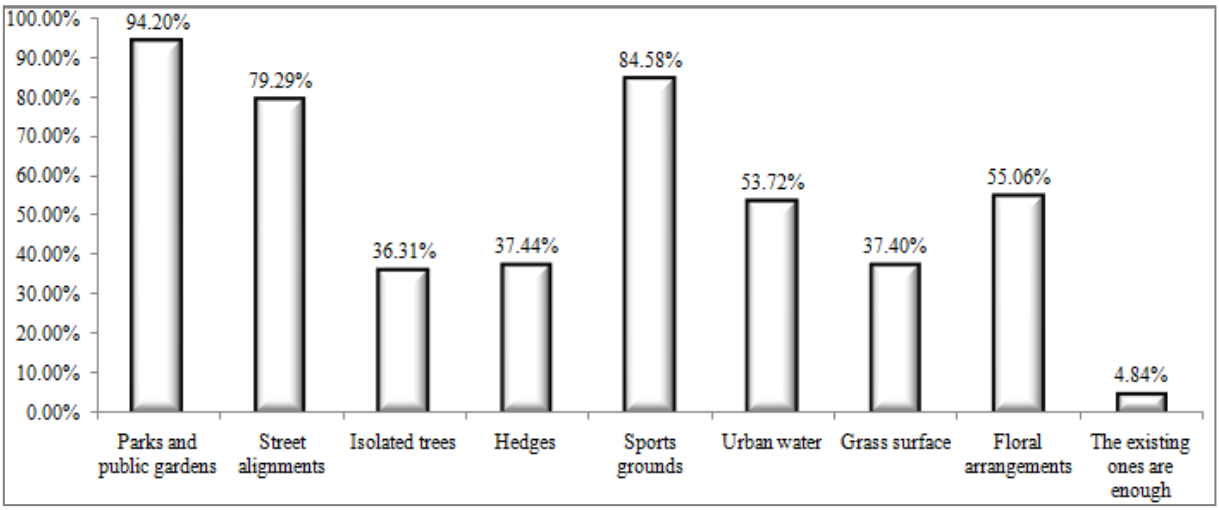

Figure 8. Categories of necessary and useful UGIs for Buzău municipality

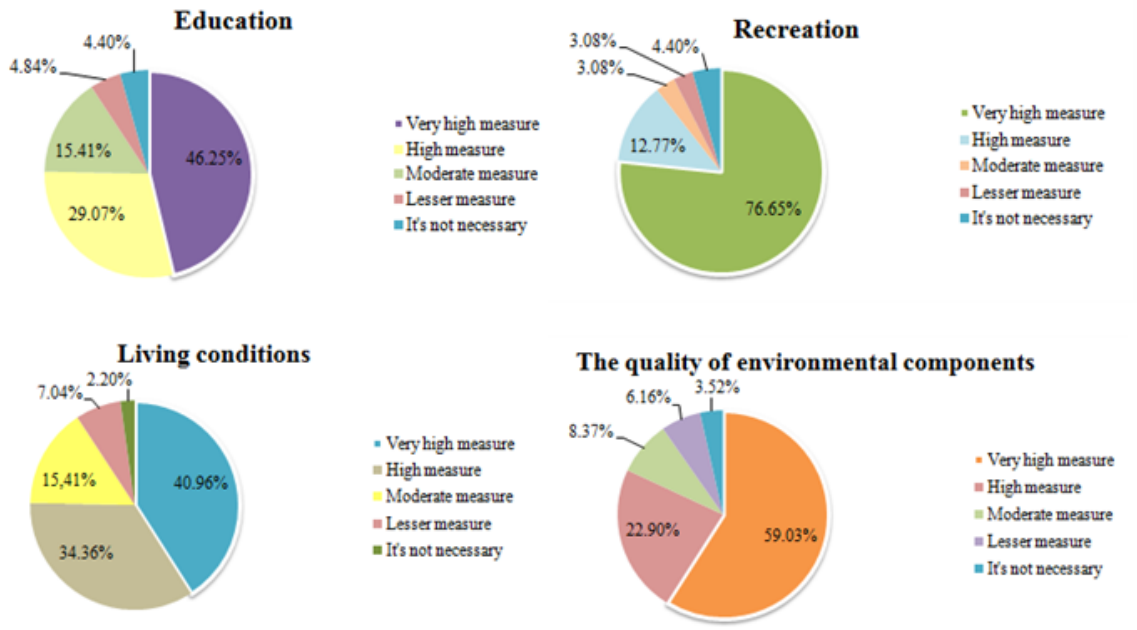

Figure 9. Quality of life benefits associated with UGI

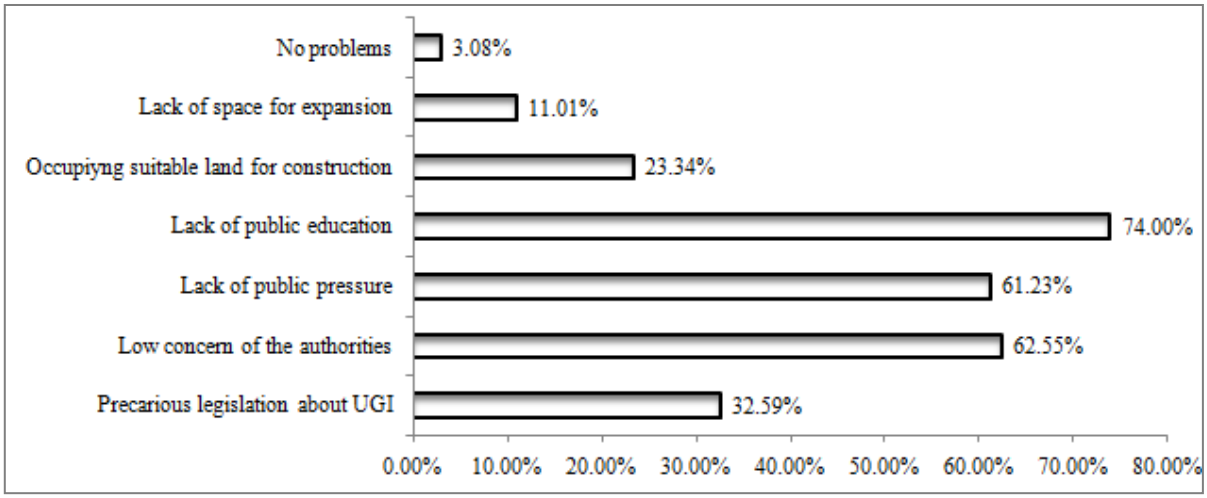

Figure 10. Deficiencies related to UVI management and planning in the city of Buzau

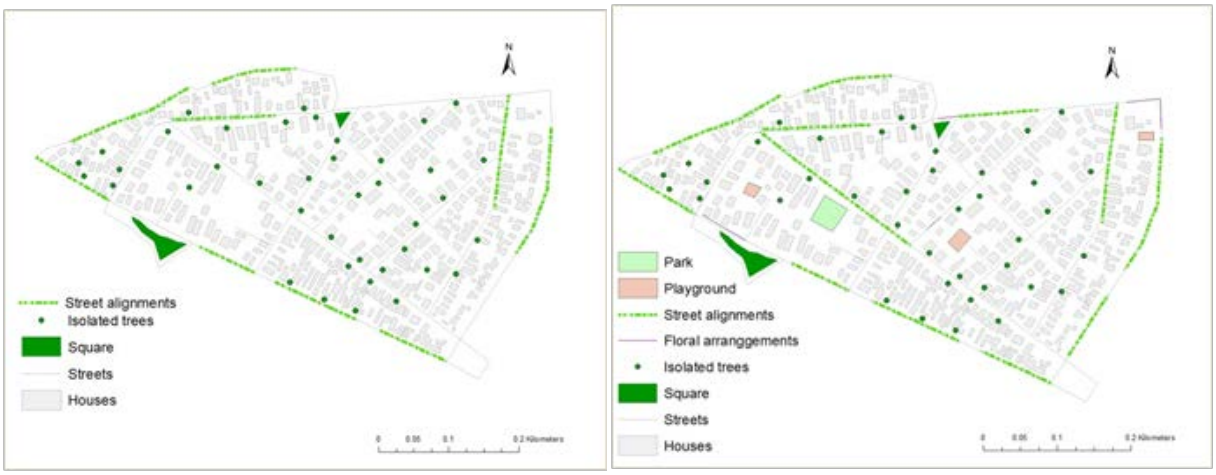

Figure 11. Solutions for changing unused space categories into green spaces in the Poștă district

Table 2. Current situation of green infrastructure indicators in the Poștă district

UGI Poștă district	Number	Surface/lenght	Land suitable for recreation ha / built area (3.76 ha)	Surface of green spaces per capita (about 2000 people)
Parks	0	0	-	-
Street alignments	5 Trees alignments 39 Isolated Trees 2 Squares	1,092 km 0.154 ha	-	0.77 sqm/place
Playground	0	0	-	-

Table 3. Changes brought about by the development of green infrastructure in the Poștă district

Solutions for UGI	Number	Surface/lenght	Land suitable for recreation ha / built area (3.76 ha)	Surface of green spaces per capita (about 2000 people)
Parks	2 Parks	0,128 ha	0.034 ha	0.64 sqm/place
Street alignments	9 Trees alignments 4 Floral arrangements 39 Isolated Trees 2 Squares	1.719 km 0.208 km 0.154 ha	-	0.77 sqm/place
Playground	3 Playgrounds	0.10 ha	0,028 ha	0.5 sqm/place

4. DISCUSSIONS

4.1. Types and distribution of UGIs in Buzău municipality

UGI can be classified according to multiple criteria. At the European Union level, typologies of green infrastructures have been established according to their position within the ecological network, as follows: core areas, restoration areas, sustainable use areas, urban and peri-urban green, areas, elements of natural connectivity and elements of artificial connectivity (Niță et al., 2017). The European Environment Agency classifies urban green spaces according to the scale at which they are assessed, from local or neighbourhood scale (school gardens), sector level (parks, green spaces of of industrial areas), to regional or municipal scale (urban forests) (European Environment Agency, 2011)

Urban green infrastructures exist in a wide variety of forms, structures and types within the city (IOER, 2007). If we refer to the provision of ecological benefits, nature conservation through the creation of specific local habitats and to the surface area in relation to the scale of application, the green space related to the Lunca Buzăului protected natural area and the Crâng forest represent the most valuable categories of green infrastructure in the municipality of Buzău. In terms of organizational structure, provision of social benefits and development of quality of life, an important role is played by parks and playgrounds related to Buzău. The most important category of UGI providing economic benefits in the municipality of Buzău is the agricultural

land on the outskirts of the city, through agricultural productivity.

According to the INSSE Tempo database, in 2018 the area of green space in the municipality of Buzău was 210 ha and the area of green space per inhabitant was 15.31 m^2/inhabitant. According to the results obtained, the current area of green space is 289.91 ha (excluding agricultural land and protected natural area, located on the outskirts of the city), so that the green area per capita is 22.45 m^2/inhabitant, referring to the population of the municipality of Buzău, estimated by the National Institute of Statistics in 2021 at 129,085 inhabitants. With Romania's accession to the European Union, the 26 m^2 of green space per capita has become a benchmark for local public administrations in their management programmes. Indeed, it is important that the area of green space reaches this minimum surface, but much more important is the composition in terms of vegetation that forms these places (Ciobotă et al., 2017).

In Europe, green space per capita varies from country to country, ranging from around 4 m^2 per capita in cities in Spain, Macedonia and southern Italy to over 200 m^2 per capita in cities in Belgium, Finland and France (Fuller & Gaston, 2009). According to the authors, the largest areas of of UGI are characteristic of Northern and Central Europe. The variation in green space per capita can vary from country to country: high values of green space per capita in cities with large areas and low values of the indicator where there is a high population density (Badiu et al., 2016). If we refer to the surface area (81.78 km^2) and population density (1,578.44 inhabitants/km^2) of Buzău municipality, it shows a satisfactory situation in terms of green space area per inhabitants.

4.2. Evaluation of the inhabitants' perception on the benefits of green infrastructures in Buzău municipality

In Buzău municipality, it is necessary to develop green infrastructures to meet the leisure needs of the inhabitants and to ensure a higher quality of life in the city. Qin et al., (2013) applied 249 subjective questionnaires to evaluate the influence of urban green spaces on humans. In this study, the use of the questionnaire allowed the identification of the desires of the human community, which can be translated into plans and projects in the future.

According to INSSE TEMPO data, the population for the year 2021 of Buzău is 129,085 inhabitants, with a male population of 60710 and a female population of 68375. Among the respondents to the questionnaire, the majority is female, in number of 125 and males responded in numbers of 102. For the municipality of Buzău, the respondents of the questionnaire consider that the green elements necessary and useful for the city are: public parks/gardens (94.20%), outdoor sports facilities (84.58%), street alignments (79.29%) and flower arrangements (55.06%) (Fig. 8). Respondents' choices are closely related to the benefits these green infrastructures provide to the local community. The selected categories of green infrastructures, i.e. parks and outdoor sports facilities, fulfil the social function through recreational activities and exercise. By involving the local community in the development process, local authorities can take into account the wishes and needs of local residents in planning and/or upgrading green infrastructure to improve the quality of life. Participatory planning can be a way to accelerate the transition to UGI (Breuste et al., 2020).

It is necessary to find a balance between economic, social and environmental protection objectives (Niță, 2016), which requires a holistic view of the existing situation and the development process. In the municipality of Buzău, it is necessary to develop green infrastructure to meet the recreational needs of residents and to ensure a higher quality of life in the city. Of the respondents 46.25% opted for a very high influence of green infrastructure on education (Fig. 9). By educating the younger generation, green space, vegetation and nature can become the object of pleasant leisure time and human care, which has positive repercussions on the attitude of future adults towards the environment (Forest Design, 2016). 76.65% of the people questioned opted for the influence of green spaces on their recreation to a very great extent and 12.77% for their influence to a great extent (Fig. 9). Green spaces are a particularly favourable environment for many recreational activities: walking, jogging, fishing, picnicking, photography or painting in the open air, observing particular tree species, etc. (Samoilă, 2007). Green infrastructure is seen as an essential factor in ensuring a high quality of urban living, (Filip, 2009). Most of the respondents opted for the influence of green infrastructure on living conditions to a great (40.96%) and very great (34.36%) extent (Fig. 9).

Respondents felt that the shortcomings related to the management and planning of green spaces are: low interest of local authorities (62.55%) but also lack of public education (74%) (Fig. 10). Thus, the population understands that an important role in the management of urban green spaces is played by the local community, through the rational use and maintenance of green space conditions. In order to expand the network of green infrastructure, one problem identified is not the lack of space, but the ownership of land. In addition, deficiencies in the management of green infrastructure also arise due to a lack of funding for possible

extensions or for the maintenance of existing spaces.

Gavrilidis et al., (2020) presented the results of a perception analysis of the concept of UGI in Romania, by sending 970 questionnaires, of which 300 were validated. In addition to determining the level of knowledge about the concept of UGI, the challenges faced by stakeholders in planning and managing UGI were also addressed. The results show that although there is a general agreement among stakeholders on providing the benefits associated with UGI, due to the lack of funds for maintenance or expansion of UGI, it is seen more as an unjustified expense and not a revenue generator for urban budgets. Respondents felt that investments in green spaces are not considered economically sustainable (Gavrilidis et al., 2020) Kolcsár & Szilassi studied green space accessibility in Zalaegerszeg city. They estimated the number of people who have access to the urban green spaces with GIS methods (Kolcsár & Szilassi, 2018).

Many European cities such as Berlin, Edinburgh, Ljubljana take public opinion into account in their UGI development programmes. For example, Beyond the Construction Site (BCS) is a project that involves local stakeholders in the planning process of brownfield sites in Ljubljana, Slovenia. The results of the project have led to the change of brownfield sites into attractive spaces for the human community (urban gardens and event spaces) (Hansen et al., 2017).

4.3. Integration of UGIs in the urban planning of Buzău municipality at different scales

Urban green spaces play a key role in urban planning due to their provision of essential ecosystem services (Gómez-Baggethun & Barton, 2013). Numerous studies over the past decade have reported the association between green spaces and health benefits at both individual and population levels (Lee et al. 2015). It is very important to consider the benefits associated with green infrastructure in urban planning. Niemela, et al., 2010 studied the use of ecosystem services for better planning and conservation of UGIs in Finland. The familiarity and use of the concept in spatial planning was studied by interviewing 24 professionals involved in land use planning and environmental management in southern and central Finland. The results of the interviews revealed a lack of information regarding the use of the concept of ecosystem services in urban planning (Niemela, et al., 2010).

The Poștă district of Buzău municipality shows a poor development in terms of green infrastructure and quality of life. Residents of this neighbourhood are exposed to accidental pollution due to its proximity to the southern industrial area. It is all the more necessary to implement actions for the development of green spaces for the benefit of the inhabitants, but also to combat environmental pollution. At the neighbourhood level, the following were identified: street alignments, located towards the industrial area, isolated trees placed in front of the houses, mostly individual, and squares (Fig. 11). There are no playgrounds or playgrounds for the inhabitants of the neighbourhood.

As solutions for this area in terms of the green infrastructure network, the necessary categories of green spaces, i.e. parks and playgrounds, could be developed on unused land (Fig. 11). Street alignments could also be developed within the neighbourhood, for better protection against pollutants and to enhance the aesthetics of the area. Depending on the changes that take place in terms of conversion of unused spaces into playgrounds or parks, the indicators for land suitable for outdoor recreation (ha/built space) and park area per capita will also change (Table 3).

Throughout the study there were limitations due to the lack of information on UGI in the city of Buzău and the lack of comprehensive and proven studies on development actions related to green infrastructure. The application of the questionnaire in the online environment implied the risk that the number of young and adult respondents was higher compared to the number of elderly respondents.

5. CONCLUSIONS

The current surface of green space in the municipality of Buzău is 286.64 ha, and the green area per capita is 22.45 m2/place, in relation to the population of Buzău, estimated by the National Institute of Statistics in 2021 at 129,085 inhabitants. Considering the surface area of the municipality and the population density, the UGI in Buzău municipality presents a good situation in terms of green space requirements. By quantifying the ecological, economic and social benefits and prioritizing the categories of UGI, the most important and valuable categories of green infrastructure in the city have been identified: the Crâng forest, the city parks and the protected natural area ROSCI0103 Lunca Buzăului. These require special attention because of their ecological component.

The evaluation of the perception of the inhabitants on the quality of the green infrastructures in Buzău municipality revealed the awareness of the respondents regarding the importance and benefits associated with the green infrastructures, but also aspects related to the need to ensure an efficient management of them. The residents of Buzău confirm the importance of green infrastructure in terms of providing ecosystem services. The questionnaires show that the most important services of urban green spaces are social (recreation – 76.65%) and ecological

(regulation of environmental components - 59.03%).

Residents' responses highlighted shortcomings in the current planning and management of UGI in Buzău. Residents (74%) identified that an important role in the management of urban green spaces is played by the local community. Regarding the sustainable development of cities, it is necessary to include a social perspective (European Commission, 2015), based on residents' wishes and solutions.

Examining the perception of 227 people revealed knowledge, expectations of the population, information that can be used in decision-making proces. Therefore, integrating the wishes and needs of Buzău residents in the planning process of green infrastructure is a priority.

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REFERENCES

Adamescu, M., Bucur, M., Giuca, R.., Cazacu, R., Cazacu, C., Arhire, G., Negrei, C. & Nițu, F., 2016. *Guide to rapid assessment of ecosystem services (Ghid pentru evaluare rapidă a serviciilor ecosistemice).* Value Eco Serv. Avaible online: http://valueecoserv.cndd.ro.

Aronson, M.F.J., Lepczyk, C.A., Evans, K.L., Goddard, M.A., Lerman, S.B., MacIvor, J.S., Nilon, C.H. & Vargo, T., 2017. *Biodiversity in the city: key challenges for urban green space management*. Frontiers in Ecology and the Environment, 15, pp. 189-196.

Badiu, D.L., 2016. *Methods for identifying and evaluating the connectivity of urban green infrastructrures in Romania (Metode de identificare şi evaluare a conectivităţii infrastructurilor verzi urbane în România).* Bucharest.

Badiu, D.L., Iojă, C.I., Pătroescu, M., Breuste, J., Artmann, M., Niță, M.R., Grădinaru, S.R., Hossu, C.A. & Onose, D.A., 2016. *Is urban green space per capita a valuable target to achieve cities' sustainability goals? Romania as a case study*, Ecological Indicators, 70, pp. 53–66.

Bolund, P. & Hunhammar, S., 1999. *Ecosystem services in urban areas*. Ecological Economics, 29, pp. 293–301

Breuste, J., Artmann, M., Iojă, I.C. & Quereshi, S. (ed.)^(eds.)., 2020, *Making Green Cities – Concepts, Challenges and Practice.* Springer Press: Berlin.

Buzău City Hall., 2017. *Joint Report on the draft decision for the approval of the Regulation on the administration of green spaces in Buzau (Raport Comun la proiectul de hotărâre pentru aprobarea Regulamentului privind administrarea spaţiilor verzi în municipiul Buzău)*. Avaible online: https://primariabuzau.ro/wpcontent/uploads/2017/01/HCL368_2017_RegulamentSpatiiVerzi.pdf.

Buzău City Hall., 2014. *Buzau Municipality Development Strategy 2014-2020 (Strategia de dezvoltare a Municipiului Buzău 2014-2020).* Avaible online: http://cjbuzau.ro/wp-content/uploads/2017/07/Strategia-2014-2020-modificata-11.2016.pdf.

Buzău City Hall., 2016. *Buzau Municipality Development Strategy 2016-2023 (Strategia de dezvoltare a Municipiului Buzău (2016-2023).* Avaible online: https://primariabuzau.ro/wp-content/uploads/2016/10/1_SIDU_Buzau_7_07_2017.pdf.

Cho, H-S., Choi, M. 2014. *Effects of Compact Urban Development on Air Pollution: Empirical Evidence from Korea*. Sustainability.6(9). 5968-5982.

Ciobotă, A., Rusu R.R., Culescu, D.L., Boancă, P.I., Condoroş, A., Bors-Oprişa, S., Bedelean, R.I., Lefter, A.R., Koos, T.A., Sîrca, M.T., Mihalciuc, I. & Weber, C., 2017. *Good practice guide for green spaces management (Ghid de bună practică pentru administrarea spațiilor verzi.) West University publishing house - Agora Collection, Romania.*

Copernicus Land Monitoring Service., 2021. Urban Atlas 2018. Avaible online: https://land.copernicus.eu/local/urban-atlas/urban-atlas-2018

Davies, C. & Lafortezza, R., 2017. *Urban green infrastructure in Europe: is greenspace planning and policy compliant?* Land Use Policy, 69, 93–101.

Dennis, M., Barlow, D., Cavan, G., Cook, P., Gilchrist, A., Handley, J., James, P., Thompson, J., Tzoulas, K., Wheater, P. & Lindley, S., 2018. *Mapping urban green infrastructure: a novel landscape-based approach to incorporating land-use and land-cover in the mapping of human-dominated systems*. Land, 7(1), 17.

Derkzen, M.L., Van Teeffelen, A.J.A. & Verburg, P.H., 2015. *Quantifying urban ecosystem services based on high resolution data of urban green space: an assessment for Rotterdam, the Netherlands*. Journal of Applied Ecologyl, 52:1020–1032.

European Commission., 2019. *Analysis of the progress made in the implementation of the European Union Strategy on Green Infrastructures* (*Analiza progreselor realizate în punerea în aplicare a Strategiei UE privind infrastructurile ecologice).* Avaible online: https://eur-lex.europa.eu/legalcontent/RO/TXT/PDF/?uri=CELEX:52019DC0236&qid=1562053537296

European Commision., 2012. *The Multifunctionality of Green Infrastructure*. Bruxelles

European Commission., 2015. *Towards an EU Research and Innovation policy agenda for nature-based solutions & re-naturing cities.* Final report of the Horizon 2020 expert group on nature-based solutions and re-naturing cities. Brussels.

European Environment Agency., 2011. *Green infrastructure and territorial cohesion. The concept of green infrastructure and its integration into policies*

using monitoring systems. In E. E. Agency (Ed.), EEA Technical report.

Fahrig, L., 2001. *How much habitat is enough?* Biological Conservation, 100:65–74.

Filip, S., 2009. *Planning Urban*. Cluj University Press, Cluj-Napoca, 332, Romania.

Forest Design., 2016. *Local register of green spaces in the city Valea lui Mihai, Bihor county (Registrul local al spaţiilor verzi din oraşul Valea lui Mihai, judeţul Bihor).*Avaible online: http://www.valealuimihai.ro/localcouncil/.

Forest Research., 2010. *Benefits of green infrastructure.* Report to Defra and CLG. Forest Research, Farnham.

Fuller, R.A. & Gaston, K.J., 2009. *The scaling of green space coverage in European cities.* Biology Letters 5 (3), 352–355.

Gavrilidis, A.A., Popa, A.M., Nita, M.R., Onose, D.A. & Badiu, D.L., 2020. *Planning the "unknown": perception of urban green infrastructure concept in Romania.* Urban For Urban Green 51:126649

Gómez-Baggethun, E. & Barton D.N., 2013 *Classifying and valuing ecosystem services for urban planning.* Ecolological Economics, 86, p. 235-24.

Hansen, R., Rall, E., Chapman, E., Rolf, W. & Pauleit, S., 2017. *Urban Green Infrastructure Planning: A Guide for Practitioners*. Green surge. Avaible online:http://greensurge.eu/workingpackages/wp5/

Haq SM., 2011. *Urban green spaces and an integrative approach to sustainable environment.* Journal of Environmental Protection, 2(5):601–608.

INS., 2018. "Database Tempo." In Bucharest: National Institute of Statistics.

IOER., 2007. *A strategy for urban green space*. Avaible online:http://www.greenkeys.org/files_manual/GreenKeys_manual_Chap_2_250808.pdf.

Jennings, V., Larson, L. & Yun, J., 2016. *Advancing sustainability through urban green space: Cultural ecosystem services, equity, and social determinants of health*. International Journal of Environmenatal Research and Public Health 13(2):196.

Kalfas, D.G., Zagkas, D.T., Dragozi, E.I. & Zagkas, T.D., 2020. *Estimating value of the ecosystem services in the urban and peri-urban green of a town Florina-Greece, using the CVM*. Int. J. Sustain. Dev. World Ecol. 27, 310–321.

Kammen, D.M. & Sunter, D.A., 2016. *City-integrated renewable energy for urban sustainability*. Science 352 (6288), 922–928.

Kolcsár, R. A. & Szilassi, P., 2018 *Assessing accessibility of urban green spaces based on isochrone maps and street resolution population data through the example of Zalaegerszeg, Hungary*, Carpathian Journal of Earth and Environmental Sciences.vol. 13, no. 1, pp. 31–36, 2018

Kremer, P., Hamstead, Z. & McPhearson, T., 2015 *The value of urban ecosystem services in New York City: a spatially explicit multicriteria analysis of landscape scale valuation scenarios Environ*. Sci. Policy 62 57–68.

Lee, A.C., Jordan, H.C. & Horsley, J., 2015. *Value of urban green spaces in promoting healthy living and wellbeing: prospects for planning*. Risk Manag Healthc Policy 8:131–137.

Lyytimäki, J., Kjerrulf Petersen, L., Normander, B., Bezak, P., 2008. *Nature as nuisance? Ecosystems and Human Well-being: Synthesis*, Island Press: Washington DC, USA.

Millenium Ecosystem Assessment., 2005. *Ecosystems and Human Well-being: Synthesis*; Island Press: Washington, DC, USA.

National Institute of Statistics., 2021. *Population by domicile on July 1* .Database Tempo. In Bucharest.

Naumann, S., Davis, M., Kaphengst, T., Pieterse, M., Rayment, M., 2011. *Design, implementation and cost elements of green infrastructure projects.* Final Report to the European Commission, DG Environment, Contract no. 070307/2010/ 577182/ETU/F.1, Ecologic institute and GHK Consulting.

Niemela, J., Saarela, S.R., Söderman, T., Kopperoinen, L., Pelkonen, V.Y., Väre, S. & Kotze, J., 2010 *Using the ecosystem services approach for better planning and conservation of urban green spaces: a Finland case study*. Biodivers. Conserv. 19, 3225–3243.

Niţă, M.R., Onose, D.A., Gavrilidis, A.A. & Năstase, I.I., 2017. *Green intrastructures for sustainable urban planning (Infrastructuri verzi pentru o planificare urbană durabilă).* Bucharest. Ars Docendi.

Niţă, M.R., Onose, D.A., Gavrilidis, A.A. & Năstase, I.I., 2014. *Develop a model for assessing the potential of green infrastructures for sustainable urban planning (Dezvoltarea unui model de evaluare a potențialului infrastructurilor verzi pentru planificarea urbana durabilă).* Bucharest.

Niţă, M.R., 2016. *Green intrastructures, a geographical approach (Infrastructuri verzi, o abordare geografica)* Bucharest. Etnologica.

Qin, J., Zhou, X., Sun, C., Leng, H. & Lian, Z., 2013. *Influence of green spaces on environmental satisfaction and physiological status of urban residents*. Urban Forestry & Urban Greening, 12(4), 490–497.

Samoilă, C., 2007. *The Green Cadastre of the University Campus located on Mamaia Boulevard (Cadastrul Verde al Campusului Universitar situat pe Bulevardul Mamaia).*124, Constanţa.

Winters, P., Piasecki, C. & Pirani, R., 2012 *"Ways to Make Green Infrastructure Work."* Regional Plan Association, November

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