Developing a model for evaluating the potential of urban green infrastructures for sustainable planning

PN-II-RU-TE-2014-4-0434

Scientific report – Phase 2

Unique phase– 2016

Content

Introduction

In 2016, the project Developing a model for evaluating the potential of urban green infrastructures for sustainable planning had one phase, whose main objectives were the evaluation of the drivers that influence the development of UGI and the setting of methods which can evaluate the potential of UGI in urban planning.

The objectives were fully accomplished through:

- the evaluation of the drivers which influence the development of UGI: the perception of different stakeholders over the development of UGI and the integration of structural, functional, administrative and economic criteria in the prioritization of UGI components has been evaluated. The stakeholders whose perception was evaluated included political and administrative factors, population, experts and economical agents.

- the setting of methods which best evaluate the potential of UGI in urban planning: a classification and a quantification of ecological, economic and social benefits of UGI has been realized; also UGI have been delimitated spatially and structurally in the urban functional areas of cities and an evaluation of UGI connectivity has been conducted.

- the mapping of the distribution of UGI in representative urban areas of Romania.

This report includes the main results obtained in the framework of the project during the period of time which corresponds to the second phase – 2016.

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1. Overview of the criteria used for the prioritization of UGI

The purpose of efficient management in urban spaces is maintaining the balance between the urban system's components (Ianos, 2004) in a way which allows different land uses to coexist not entering in conflict with each other (Ioja et al., 2014b). The challenges that arise in the process of urban planning are very complex and sometimes they are difficult to predict especially in post-socialist countries (Stanilov, 2007). Some deficiencies in the urban planning process can be overlooked by experts or by authorities but not by people. In the end, people are the beneficiaries of the urban system's functionality. That is why, the process of urban planning has to be directed towards the benefit of the population and to meet the needs of the residents. (Ciocanea, 2013)

For urban planning, as a complex process, even when discussing about certain components, in order to be efficient and sustainable, experts and authorities have to include in this process the analysis of the perception of the population or any other interested part. (Carstea, 2008) Whether the topic of interest is the quality of life (European Comission, 2010), the reconversion of industrial sites (Saghin et al., 2012), urban landscape (Conrad et al., 2011) or urban green areas (Hofmann et al., 2012; Iojă et al., 2011; Qureshi et al., 2010; Zhang et al., 2013), researchers have used methods of perception's analysis in order to find the best solutions. Even if the questionnaire and the interview are originally sociological instruments, they can be used in different domains, especially in those that focuse on life quality improvement (environment, geography, urbanism, architecture etc).

Because the research of urban areas has to have a strong information background, it is necessary to integrate the perception's analysis of the direct or tangential institutions which are involved in the cities management but also of the economical agents which operates on the territory of these cities along with the analysis of the population's perception. As mentioned before, the challenges that arise in the process of planning are complex and that is why the persons who are directly involved have to have different background formations. Multidisciplinary teams involved in this process can guarantee the efficiency of the proposed solutions and that is why the expert opinion evaluations are very useful.

The management and the planning of urban green infrastructures (UGI) represent an essential component in the process of urban planning (Dige, 2011) because UGI influence in a significant way the quality of urban life (Nedelciu et al., 2013). From a research perspective, the process of planning the UGI has to comprise a series of phases which are well defined in order for this to generate the expected outcomes. (Figure 1)

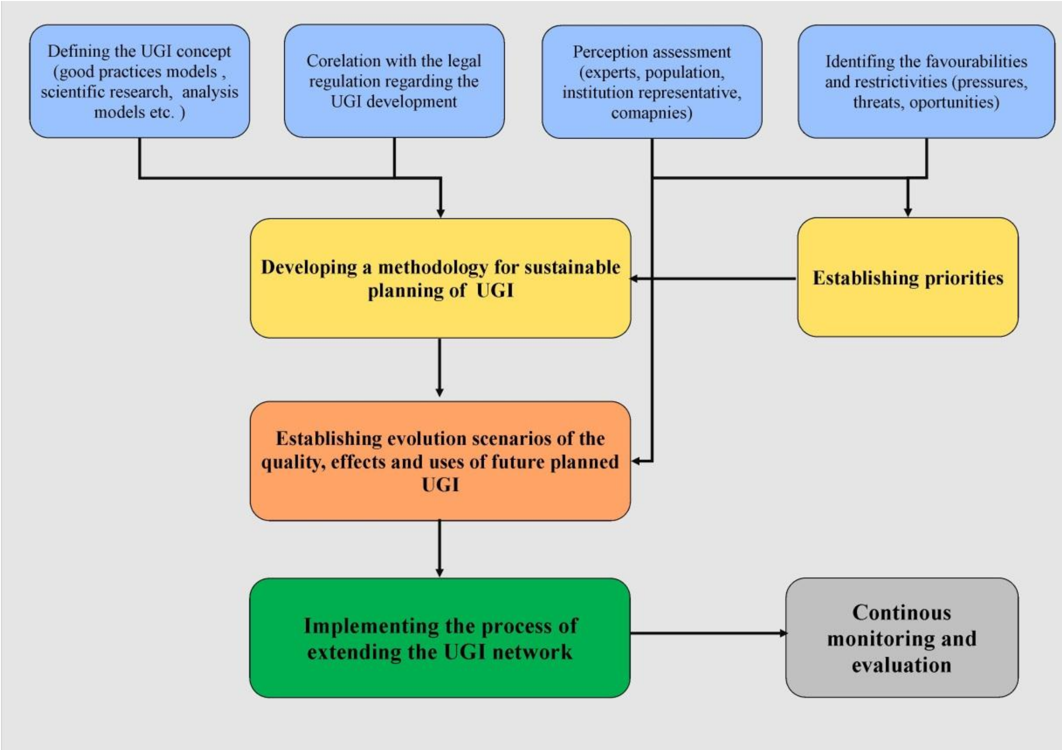


Figure 1 Phases in the process of planning and developing an urban green infrastructures network

During the project PN-II-RU-TE-2014-4-0434, the perception's analysis were oriented towards four different directions which included: experts, population, public institutions representatives and economical agents.

1.1. Methods applied in the perception's evaluation

Firstly, it was considered an expert opinion based analysis (Iojă et al., 2014b; Onose et al., 2015a) which had two main objectives: to identify the criteria which need to be used in the planning of UGI and to set a classification of UGI which are necessary in different urban functional areas in order to amplify their efficiency. The method used in the ranking of the criteria was a multicriteria analysis, which was followed, based on the hierarchy resulted, by a prioritization of UGI types which better fit different urban functional areas of a city. The number of chosen criteria was nine, their election being based on international scientific references. Further explanations and references are detailed in Table 1.

The second phase of the UGI planning consultative analysis was based on the evaluation of perception for population, public institutions representatives and economical agents. This process was conducted using as an instrument for evaluation the questionnaire (Chelcea, 2007). The questionnaires for the three target groups contained common items but also some specific items in relation with the group for which they were applied. The questionnaire is structured in 6 sections: a) general information; b) definition of UGI concept; c) benefits and restrains induced by UGI; d) the management of UGI; e) specific problems; f) identification data. The survey was applied to the targeted group through an online environment.

Table 1 Criteria chosen for the multicriteria analysis

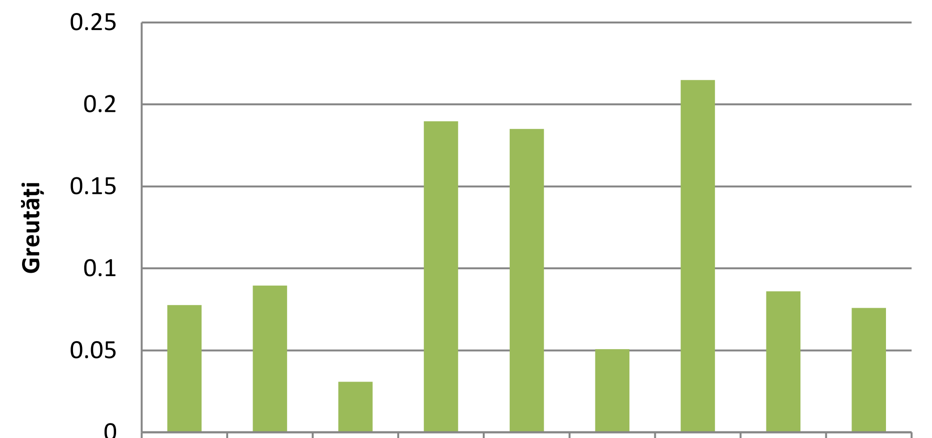
Criteria	Acronym	Reference
Management costs	man	(Ioja et al., 2011)
Ease of construction	bld	(Grădinaru et al., 2015)
UGI type's popularity in Romania	acc	(Cicea & Pirlogea, 2011)
Efficiency in fighting climate changes	cce	(Carter, 2011; EEA, 2012; European Commission, 2012)
Efficiency in air quality improvement	aqi	
Economical potential profit generated by the UGI	epr	(Sýkora & Ourednek, 2007)
Benefits in biodiversity conservation	bdb	(Hostetler et al., 2011; Jabareen, 2013)
Social interaction stimulation	sns	(Thompson et al., 2013; Wolch et al., 2011)
Specific – natural conditions (relief, hydrology, vegetation)	spf	(Pulighe et al., 2016)

The methods for analyzing the perception of different groups on the UGI subject were applied in many studies. Our questionnaire was built following the structural classical approach which focused on the attitude towards green areas, activities related to the environment, gender, level of education and income of the respondents (Barlam & Dragice). This type of perception studies can determine a better understanding of the way in which certain group access the green areas but in the same time can underline which are the restrictive or favorable factors for the accessibility of green areas (Schipperijn et al., 2010). These aspects are investigated also by our analysis through the section dedicated to the identification of problems in the management of green areas. Thus, one can compare the population's perception and the public institutions representatives perception, but at the same time one can observed the private way of managing these type of spaces based on the information extracted from the survey applied to economical agents.

The multicriteria analysis based on expert opinion was conducted during several months, from May to August 2016. The questionnaires dissemination towards the target groups started in August 2016 and it is still ongoing. The final results should be generated at the end of the year.

1.2. Integration of structural, functional, administrative and economic criteria in the process of UGI prioritizing

The multicriterial analysis underlined the fact that the highest scores characterized the criteria which focused on overcoming environmental problems (biodiversity conservation, fighting climate change and the improvement of air quality), the lower scores being for the ones related with the pragmatism of UGI planning (economic profit or popularity of UGI type in Romania) (Figure 2).



	man	bld	acc	cce	aqi	epr	bdb	sns	spf
Weight	0.0776	0.0896	0.0308	0.1896	0.1849	0.0508	0.2147	0.086	0.0759

Figure 1 Weights resulted from the multicriteria analysis for all 9 criteria selected

Twenty seven types of UGI were selected (Cvejić et al., 2015; Dige, 2011). Following the expert opinion based analysis; these types of UGI were ranked on their efficiency for the five functional areas in an urban environment: agricultural areas, industrial areas, commercial areas, collective residential areas and single-family residential areas. The results are summarized in Table 2, the final detailed form is going to be presented in a scientific paper which is under review. The study was based on a complex analysis of types of UGI and also on a proposed methodology for the proper identification of available land to develop UGI network.

Until this report, the answers obtained in the process of evaluating the perception of population, public institutions representatives and economical agents covered 40 of the 41 counties plus Bucharest municipality, except Braila County which has not provided any answer from any of the target groups (Figure 3).

Table 2 Types of UGI recommended for the five functional areas analyzed

Agricultural areas	Industrial areas	Commercial areas	Collective residential areas	Individual residential areas
Ecological farms Pastures Transitional ecosystems between natural and seminatural areas Rivers Orchards Protection forests Floodplain forests Hedges Protected areas of local importance	Protection forests Street Tree alignments	Street tree alignments Single trees Green roofs Public parks and gardens Sustainable sewage network	Public parks and gardens Street tree alignments Green roofs Single trees Squares with flowers and lawn Vertical gardens Sustainable sewage network Squares with lawn Protection forests Flower pots Private gardens	Public parks and gardens Street tree alignments Sustainable sewage network Single trees Squares with flowers and lawn Hedges Protection forests Rivers Patches of forests

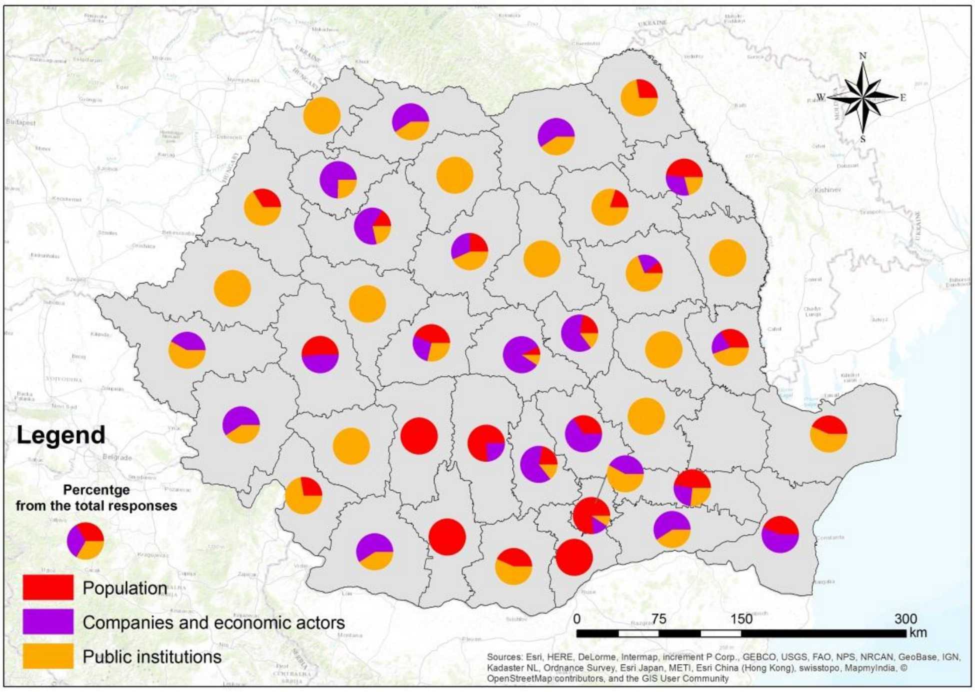


Figure 3 Responses rate on each target group at county level

The majority of responses in the target group of public institution representatives were obtained from city halls, local councils, environmental agencies and county councils (Figure 4). There have been registered some answers from central institutions such as General Inspectorate for Emergency Situations (IGSU), National Agency for Cadaster and Registration (ANCPI), National Environmental Guard and the Institution of People Advocate.

The economic agents who responded to the survey are involved in different activity sectors, most of them belonging to industry, services and design (Figure 5).

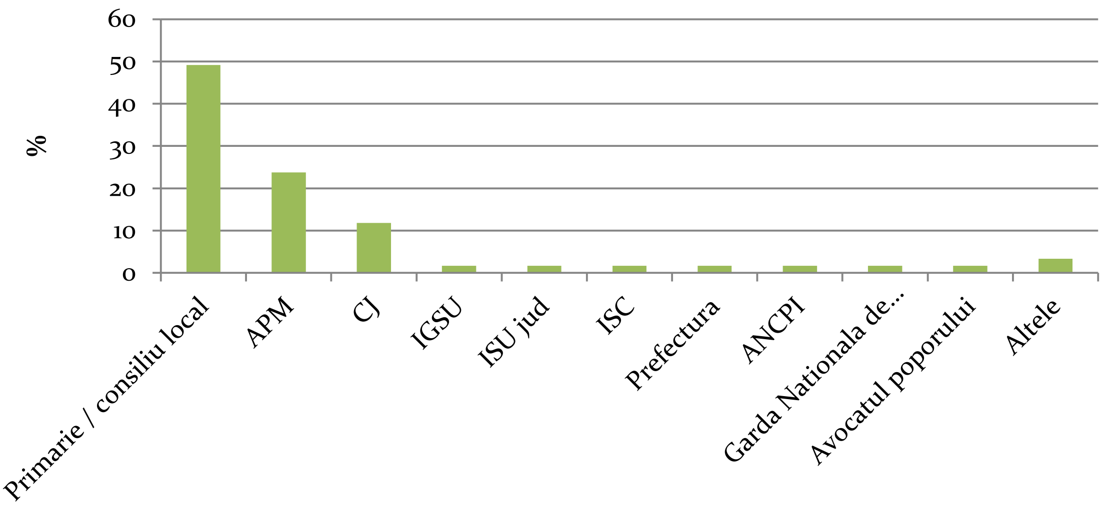


Figure 4 Institutions categories which responded to the survey

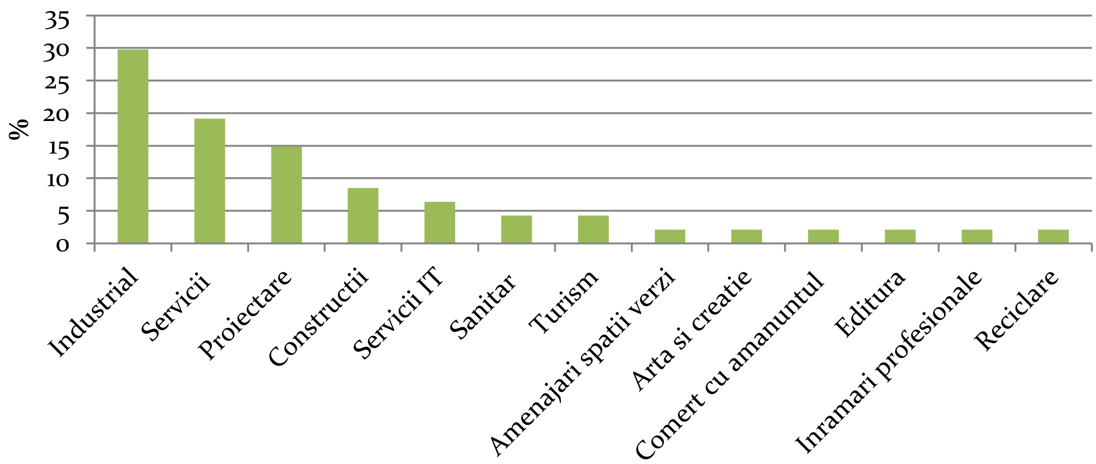


Figure 5 Activity domains of economical agents

The age categories which describe the population respondents are between 18 and 65 years. The preliminary analysis of responses allowed the comparative evaluation of commune questions between the three targeted groups and the identification of differences in their perception. In the first part of the questionnaire – defining the concept of UGI – over 60% of the respondents from each target group had knowledge about this concept (Figure 6). 40 % of the respondents define the concept of UGI as the total of public and private green areas in a city (Figure 7).

84.3% from the population respondents and 79.4% from the public institutions respondents considered the maintenance costs as the biggest challenge in the management of UGI. Only 11.1% of the respondents had the same opinion with regard to the green areas that they administrate. The majority of answers (55.6%) from the economic agents group hadn't identified any problem regarding the management of green areas under their administration.

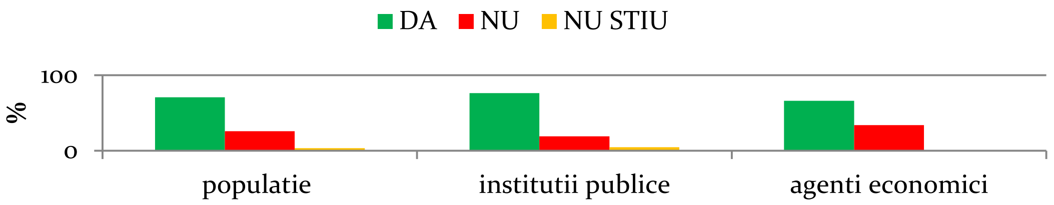


Figure 6 Target groups knowledge about the concept of UGI

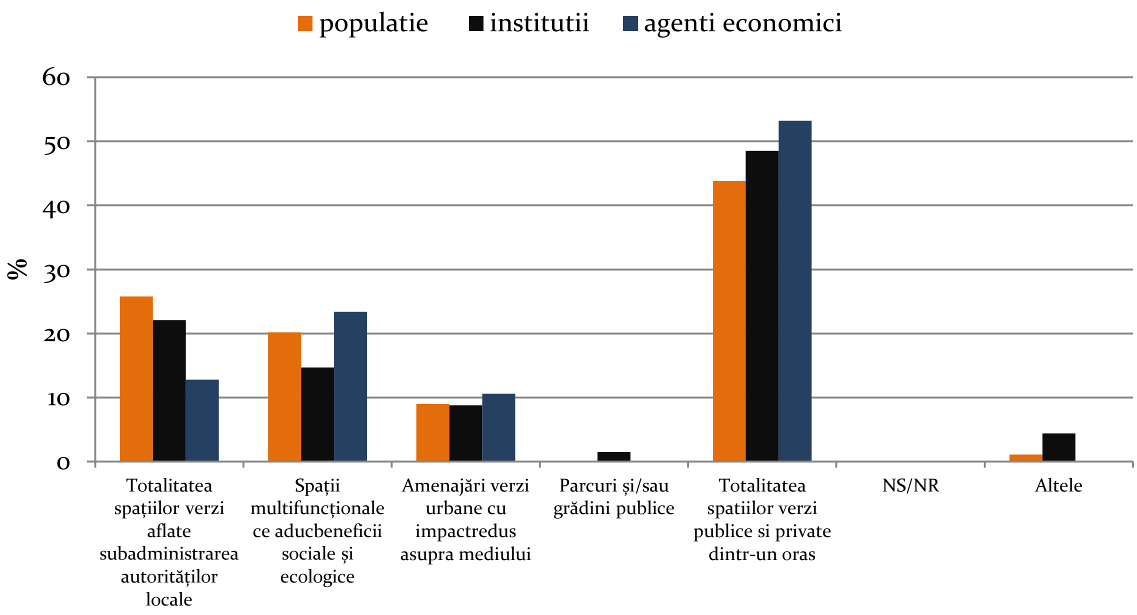


Figure 7 Target groups concept's definition

58.4% of the population respondents admitted that they would be willing to contribute financially to the enlargement of UGI network if a tax had been required. On the other side, only 7.4% of the public institution representatives considered this idea as being feasible. The majority of respondents (42.6%) considered this idea impossible to apply because of the population perception. The population respondents and also the public institutions representatives indicated public health, recreational spaces, environmental quality and the surface of green areas per capita as components on which UGI would have a positive impact.

70.2% of the economic agents who responded to this survey have a green area in their administration, the majority (53.8%) declare that they have trees or shrubs. From the economical agents point of view The main benefit linked to green areas is the esthetics of the institution (74.4%) and39.5% have considered to expand the green areas.

1.3. Discussions

The completion of the evaluation regarding the three targeted groups' perception regarding UGI is needed in order to elaborate a proper and specific methodology for the management and planning of UGI in a city. Firstly, it is necessary to understand the population's knowledge about the concept of UGI but also which are its needs that can be fulfilled by an efficient management or by the expansion of UGI (Patroescu et al., 2004). Also, the public institutions view over the subject is important because they have competences in the management and planning of UGI. This analysis will underline the challenges and the deficiencies with which the local and central authorities are struggling. Lastly, the economical agents can play an important role in the administration of green areas improving the public network of UGI. That is why the monitoring of their perception is vital in the context of an integrated monitoring of UGI.

Our results correlate with other studies which show that UGI have a positive image in the population's perception and their expansion is desired by the majority of the residents (Iojă et al., 2010). Contrary to other studies which concluded that the population is satisfied with the authorities management of UGI (Jim & Chen, 2006), our preliminary results show a high percentage (68.5%) of unsatisfaction regarding the management of UGI. The comparative analysis is necessary to identify the best solution which can be applied in a domain (Priego et al., 2008). The perception's comparative analysis over the three groups of stakeholders will permit the understanding of the deficiencies which lead to not considering the UGI as efficient to satisfy the population's needs (Cucu et al., 2011). The work group can propose viable and unanimously accepted solutions for a better management for the existent UGI but also for the correction of errors which can affect the way of planning future UGI.

2. Overview on the evaluation of UGI connectivity

2.1. Classification and quantification of ecological, economic and social benefits of UGI

Nowadays, urban green infrastructures are the main ecosystem services providers in urban areas affected by climate change, population growth and by a large resources consumption (Rees, 1997). The benefit providing capacity for the residents depends on the quality and quantity of the categories which are composing the green network, along with the connectivity established between them.

The urban green infrastructures categories present ecological, social (cultural or recreational) and economic functions (Table 3). Through the provision of these benefits, the urban green infrastructures are contributing to the improvement of the quality of life and of the population health (Nita, 2016).

Table 3 The benefits provided by the urban green infrastructures

No.	UGI Category	Benefits	Example
1	Urban parks	Ecological benefits	Improvement of air quality (Yang et al), biodiversity conservation through the creation of support habitats for the local species of flora and fauna (Cornelis & Hermy, 2004);
		Social benefits	Improvement of landscape esthetics, recreational areas, creation of opportunities for socializing, sports areas (Chiesura, 2004) and the improvement of population's heath
		Economic benefits	Attractiveness growth for the residential space, reduction of energy consumption through constant temperature preservation at a local scale.
2	Urban forests	Ecological benefits	Improvement of air quality through carbon sequestration, biodiversity conservation through the creation of support habitats for local species of flora and fauna (Hobbs, 1988), reduction of the urban heat island effect (Gill et al., 2007)
		Social benefits	Improvement of landscape esthetics, recreational areas
		Economic benefits	Reduction of energy consumption through constant temperature preservation at a local scale.
4	Neighborhood gardens	Ecological benefits	Reduction of erosion caused by runoffs (Mentens et al., 2006), support space for species of flora, birds and invertebrates (Cameron et al., 2012)
		Social benefits	Space for relaxing and socializing
		Economic benefits	Residential space value growth
3	Street tree alignments	Ecological benefits	Improvement of air quality, the existence of protection windbreaks against gass pollutants, the reduction of the noise pollution negative effects
		Social benefits	Promenade space for the residents

		Economic benefits	Residential space value growth (McPherson et al., 2005)
5	Schools gardens	Ecological benefits	Improvement of air quality due to vegetation, the reduction of the noise pollution negative effects
		Social benefits	Recreational spaces and the safe practice of educational activities (Iojă et al., 2014a; Ozer, 2006).
6	Public institutions gardens	Ecological benefits	Reduction of erosion caused by runoffs
		Social benefits	Space for relaxing and socializing, Improvement of urban landscape esthetics
7	Sports fields	Social benefits	Improvement of population's health through the promotion of sports practice (Swanwick et al., 2003).
8	Squares	Ecological benefits	Reduction of erosion caused by runoffs
		Social benefits	Improvement of urban landscape esthetics
9	Green areas associated to industrial or commercial areas	Ecological benefits	Reduction of erosion caused by runoffs
		Social benefits	Improvement of urban landscape esthetics

The methods used for the classification and quantification of the benefits provided by urban green infrastructures are qualitative (for the evaluation of recreational spaces and for social benefits) or quantitative (ecological or economic benefits).

One of the most recent approaches regarding the urban green infrastructures benefits is linked by the quantification of urban ecosystem services. Through the evaluation of ecosystem services provided by urban green infrastructure, a tangible value is attributed to these benefits which is more efficient to manage by the decisional authorities. For the evaluation of ecosystem services in urban environments, the European Commission has published the report ***Mapping and assessment of urban ecosystems and their services*** (Rocha et al., 2015) which presents a series of indicators used for quantifying the provision, regulatory and cultural services.

Indicators for the evaluation of urban green infrastructures provision services:

- Biomass quantity of big and mature trees per forest hectare (t/ha)
- Number of species which present medical value per hectare, the harvested quantity (no./ha , euro/ha (kg or t)/ ha)
- Forest cover (%)

Indicators for the evaluation of urban green infrastructures regulatory and support services:

- Quantity of carbon sequestrated in the trees canopy (t/ha)
- Pollutants retained by trees and shrubs (PM_{10} and $PM_{2.5}$, SO_2, NO_2, CO, O_3, CO_2) (t/ha/year)
- The capacity of water storage in vegetation and soil (t/km^2)

- Cooling by vegetation (°C)
- Reduction of green gas emissions (%)
- Trees shading area (urban climate regulation) (m^2)
- Trees cooling potential (t C/ha)
- Total surface of public green areas (m^2)
- City's ecological footprint (tCO_2)

Indicators for the evaluation of urban green infrastructures cultural services:

- Suitable space for open-air cultural activities (m^2)
- Number of recreational areas (number)
- Urban green infrastructure proximity to the alternative ways of transportation (km)
- Recreational potential (between 0 and 1)
- Parks surface per capita (ha/inhabitant)
- Spatial distribution of runners and bikers (number of runners and bikers/ hour/km)
- Kids playgrounds surface (m^2)

In the context of a bad management, urban green infrastructures can lead to environmental problems (Table 4). The most known problems that can affect the urban residents quality of life are the dispersion of pathogen agents, of plants that cause allergies, pests and diseases determined by fauna and flora which exist in urban green infrastructures (Dunn, 2010; Lyytimäki et al., 2008). Additional to the potential ecological problems, urban green infrastructures can create the premises for some social problems. For example, planning parks at the edges of neighborhoods which are characterized by different economic status can lead to social conflicts (Iojă et al., 2015).

Table 4 Examples of environmental problems caused by urban green infrastructures – (after Escobedo et al., 2011; Lyytimäki et al., 2008)

Social problems
Pathogen agents
Plants that cause allergies
Insecurity
Drivers for diseases (lyme, rabies)
Abundant vegetation that creates a discomfort
Ecological problems
Aerosols and volatile organic compounds
The presence and the mobility of invasive species
Economic problems
Management costs for green areas
Obstruction of pedestrian roads caused by trees roots
Buildings degradation caused by wood decomposition
Usage of surfaces that can have another more profitable use

Even though the number of urban green spaces benefits and the associated biodiversity may be higher than the number of disservices, it is important that both perspectives are analyzed when planning for the residents needs

2.2. Spatial and structural delimitation of UGI in the urban functional areas

Cities are characterized by a complex way of land use (Salvati 2014, Puertas 2014). The urban development is influenced by a large number of factors such as: natural environments, demographic and economic evolution and urban planning approach. This is why cities are seen as complex systems which generate socio-economic patterns (Amorim et al., 2014) in the urban landscape as a functional zooning of space whose sole purpose is to satisfy the social, economic and ecological demands (Jaeger et al., 2010). The rapid transformations at the urban level are frequently done through free space consumption and resource depletion as they determine many problems for the management and the planning of such areas.

The planning process in urban areas is based on Law 350/2001 which offers as instrument the urbanism documentation – the masterplan. This has a directional feature and regulates the land use in the city's core area and also the functional zooning correlated with the road network. This document comprises stipulations for medium and long time.

The masterplan represents an important data source regarding green areas planning in cities. This document has a written part which includes the memoir and the local regulations for urbanism but also a graphical part which underlines the distribution of functional areas across the city.

An essential component of urban green infrastructures are the green spaces functional areas. Important aspects which are pursued in the planning of such areas are the provision of recreational areas, the control of climatic and hydrologic indicators, the provision of habitat for local flora and fauna and the food productivity (Niță, 2016).

The green spaces Law 24/2007 (47/2012) defines these green areas in the next categories:

A.	Free access public green area: parks, gardens, squares, planted strips
B.	Specialized public green areas
	1. botanical gardens, zoo, open-air museums, exhibition parks
	2. the ones belonging to public institutions: kindergartens, schools, hospitals, churches, cemeteries
	3. sports areas for performance sport
C.	Recreation green spaces: recreation bases, recreation poles, sports areas
D.	Green areas for water bodies protection
E.	Protection corridors for the technical infrastructure
F.	Recreational forests
G.	Greenhouses

The main data source for the analysis of urban green infrastructures spatial distribution was the masterplan itself. This type of document was accessed using the web pages of local authorities – town halls, urbanism departments. From 319 cities analyzed, only 87 had the masterplan documentation publicly posted on their website.

The written part of the masterplan documentation was consulted for 87 cities from Romania (1- rank 0, 8 rank -1, 41 – rank 2, 37 – rank 3) (Figure 8). The following information were extracted, if possible:

- the presence/absence of a green area type
- percentage of land occupancy POT
- coefficient of land usage CUT (Figure 10)
- allowed activities
- regulations over planted areas in other functional zones: central area, mixed area, residential area, production area etc.

After this phase of data collection, maps were created to present the general situation at a national level for the analyzed cities.

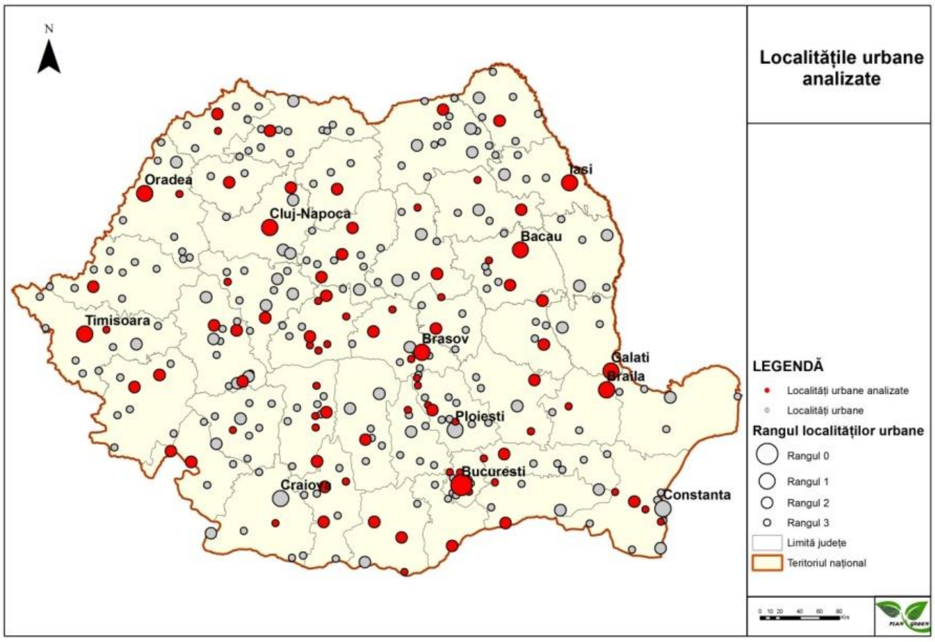


Figure 8 Cities included in analysis

Figure 9 shows the percentage of green areas at a national level. A small number of cities have surfaces of green areas over 20% of the city's core area (Borsec and Arad) and some oscillate between 10 and 20% (ex. Bistrița, Cluj, Abrud, Câmpina etc). The map underlines a cluster of such cities in the central part of the country.

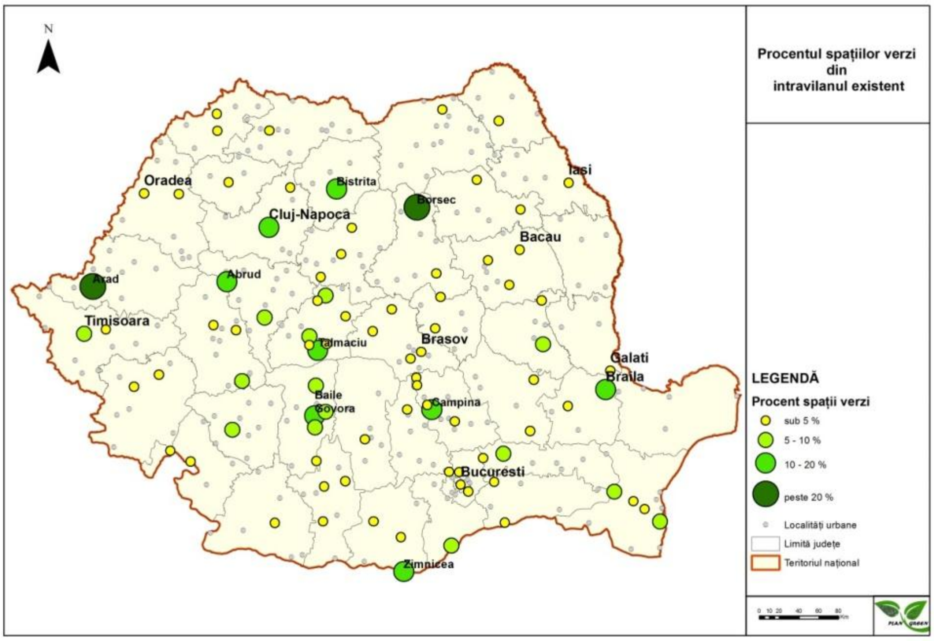


Figure 9 - Percentage of green areas in analyzed cities

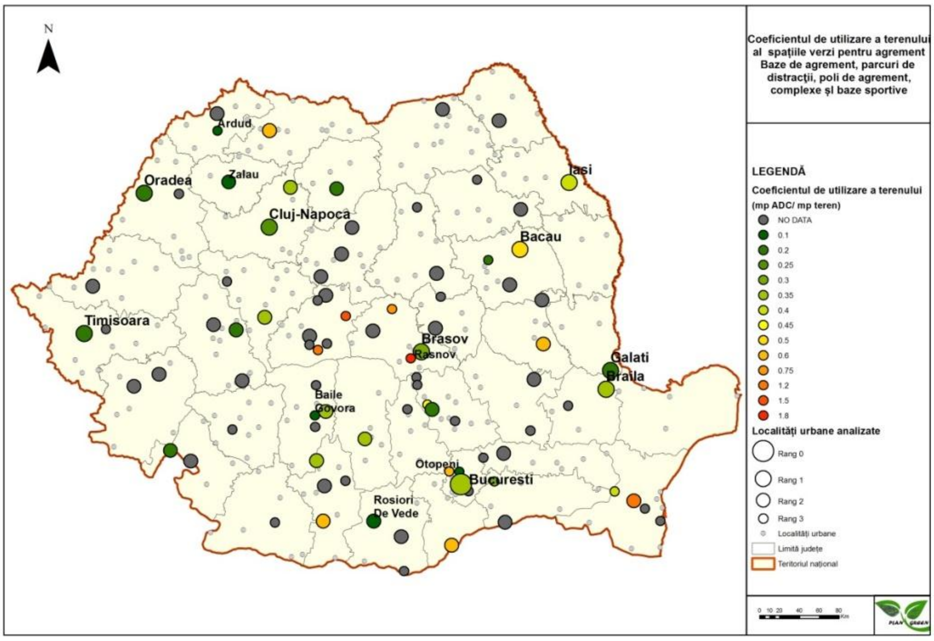


Figure 10 - The values distribution of the coefficient for land usage in analyzed cities

Another aspect that was analyzed from the data extracted was the dynamic of green spaces at city level. Because the masterplan presents the development directions of a city, it has included in its written and graphical documentation a part containing urbanistic proposals. Thus, a comparison has been made between the percentage of green spaces in the existent core area and in the proposed one. The majority of masterplans propose the green areas growth in surface.

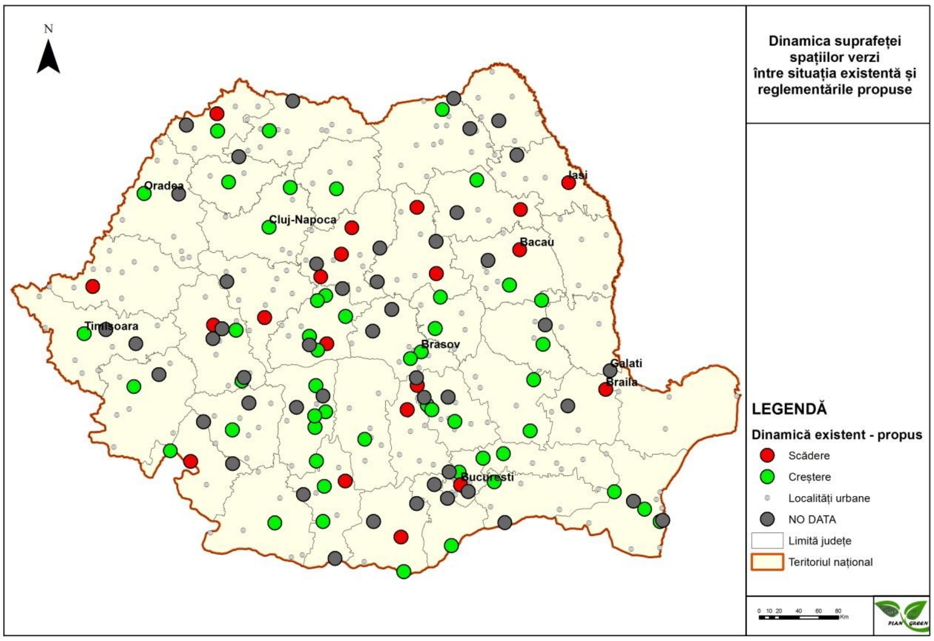


Figure 11 - The dynamic of green areas

From the 87 cities that were analyzed, 7 were selected having different ranks in the cities network and a mapping exercise has been made for their functional areas having the masterplan as base map. The preliminary result was the creation of a GIS database which can be the start for understanding of the spatial relationship between urban green infrastructures and other functional areas. Next phase consists in applying a spatial analysis based on distance indicators.

2.3. Evaluation of UGI connectivity

The concept of connectivity represents a key element in the context of sustainable planning, even if it is about natural or urban connectivity.

Connectivity can be defined by the capacity of an area to sustain the dispersion and the mobility of materia, energy and organisms (Taylor et al., 1993). There are two categories of connectivity which are studied in the field of biogeography: structural connectivity and functional connectivity (Crooks & Sanjayan, 2006). The structural connectivity represents the capacity of an area to sustain the ecological flows of materia and energy without taking into account the species needs for habitat and mobility (Kadoya, 2009). The functional connectivity represents the possibility of organisms to disperse in order to maximize the degree of viability for populations (Forman, 2006; Taylor et al., 1993). Besides the concept of local flora and fauna dispersion, the connectivity analysis in urban areas focused also on the residents mobility between urban green areas in order to satisfy their needs for recreation, socialization or for practicing physical activities (Iojă et al., 2014a) (F2).

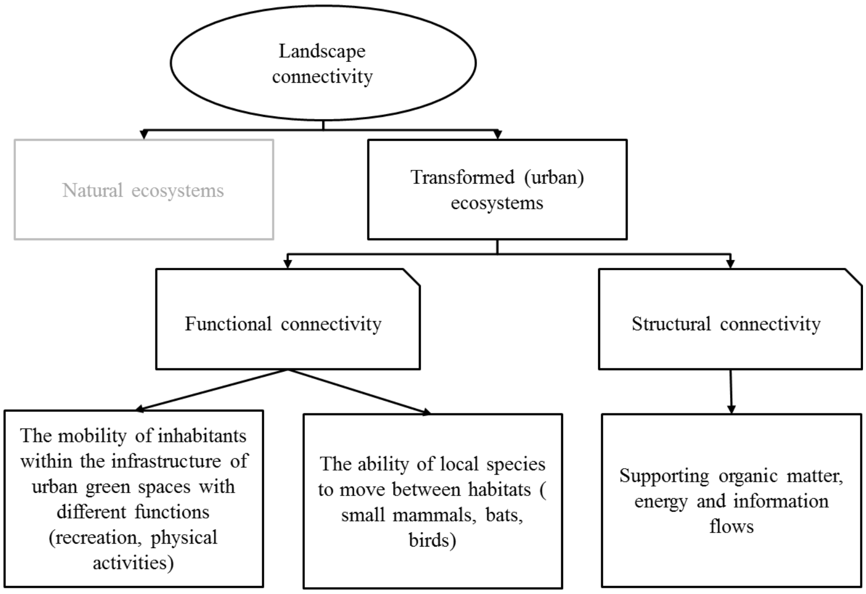


Figure 12 Hierarchy of connectivity categories (based on Rudd et al., 2002; Kong & Nakagoshi, 2006; Marulli & Mallarach, 2005)

In order to establish the degree of structural connectivity, landscape indicators are used (Kindlmann & Burel, 2008; Kong & Nakagoshi, 2006) but many times the obtained results are redundant and they don't offer a realistic image over the ecological processes (Kupfer, 2012). However, the data obtained from the calculation of indicators (Table 5) requires a small number of data and can be considered as the preliminary results in the connectivity analysis.

Table 5 Examples of landscape metrics used in the evaluation of structural connectivity, after (McGarigal, 2014)

Indicator	Formula and calculation	Importance
Total Core Area (TCA)	**TCA**= $\sum_{j=1}^{n} a_{ij}^{c} \left(\frac{1}{1000}\right)$ $\boldsymbol{a_{ij}^{c}}$= patch ij central surface (m^2) based on the specified edge (m)	Total Core Area represents a relevant indicator for the urban green infrastructures connectivity. Based on this, the total surface of green elements is quantified (at network level and at category level) after the elimination of an edge buffer.
Edge Density (ED)	**ED**= $\frac{\sum_{k=1}^{m} e_{ik}}{A}(10000)$ $\mathbf{e_{ik}}$= total length (m) of an patch's edge at landscape level A =total landscape surface (m^2)	Edge Density evaluates at a network level and green space category level the length represented by edges per hectare.
Euclidean Nearest-Neighbor Distance (ENN)	**ENN**=$\mathbf{h_{ij}}$ $\mathbf{h_{ij}}$= distance(m) from the focal patch ij to the closest patch from the same class	The indicator offers information regarding the isolation of patches and of their closeness.
Proximity Index (PROX)	**PROX**= $\sum_{s=1}^{n} \frac{a_{ijs}}{h_{ijs}^{2}}$ $\mathbf{a_{ijs}}$=surface (m^2) of ijs patches from the specific vicinity of the patch ij $\mathbf{h_{ijs}}$=distance (m) between patches calculated from center to center	The indicator offers information regarding the distance between patches in a specific areas and it calculates the degree of proximity based on the patch surface.
Connectance Index (CONNECT)	**CONNECT**= $\left[\frac{\sum_{j=k}^{n} c_{ijk}}{\frac{n_i(n_i-1)}{2}}\right](100)$ $\mathbf{c_{ijk}}$=level of association between patches j and k (where 0-unassociated and 1=associated) based on a specific distance $\mathbf{n_i}$= number of landscape patches from the same class	The indicator underlines the number of connections settled between patches transposed in a percentage of the maximum level of connectivity.

Functional connectivity is evaluated through complex analysis like Travel Cost (Marulli & Mallarach, 2005), *Graph Theory* (Foltête et al., 2014; Niculae et al., 2016; Urban & Keitt, 2001) or through specialized programs which analyze the capacity of dispersion for species in a certain area (McRae et al., 2008; Moilanen et al., 2009; Saura & Torne, 2009).

Examples of connectivity indicators calculation for cities in Romania

The urban green infrastructures with the most expanded central surfaces (Total Core Area) are part of rank I or II urban areas (ex. Iași, Brăila, Piatra-Neamț, Constanța, Oradea) in comparison to the smallest surfaces from rank III cities (ex. Isaccea, Negru Vodă, Piatra-Olt, Odobești, Baraolt) (**Error! Reference source not found.**). The reported aspect is due to the pattern of urban green infrastructure with a majority of parks and residential gardens in important cities.

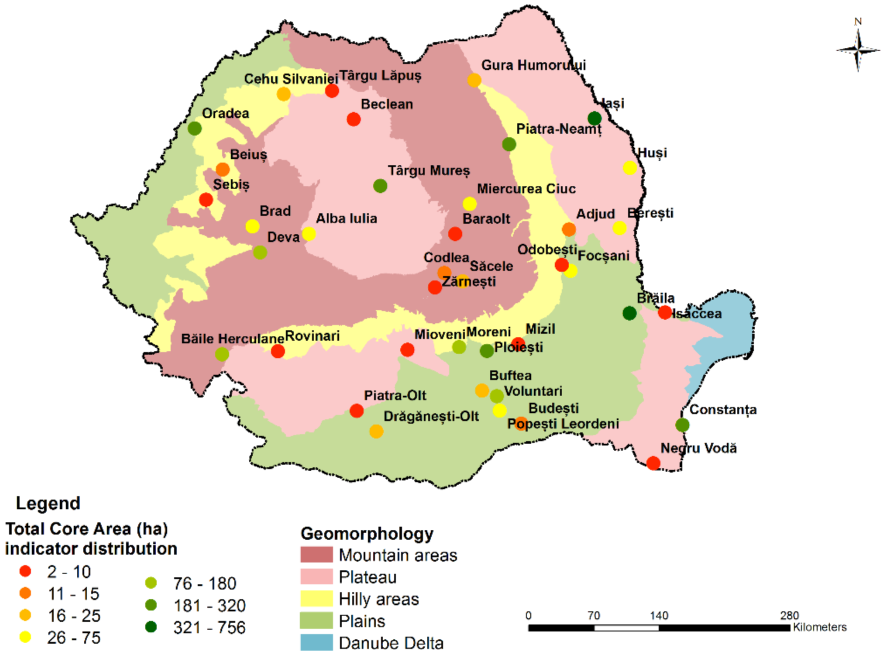


Figure 13 The distribution of indicator Total Core Area in Romania's cities

The calculation of Edge Density indicator underlines a higher heterogeneity than for the first indicator (Total Core Area) with values not having a uniform distribution between the three categories of ranked cities (Fig. 14).

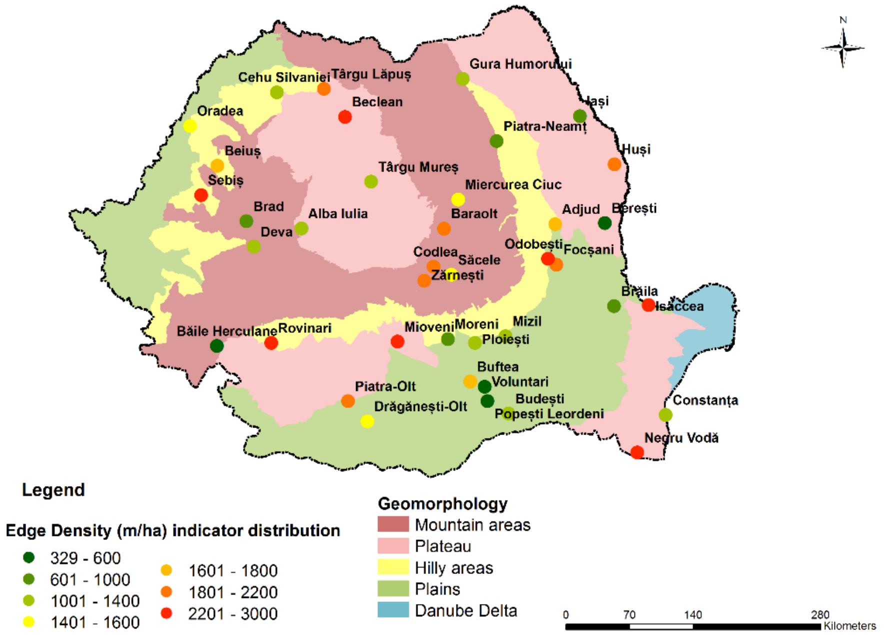


Figure 14 The distribution of Edge Density indicator values in Romania's cities

The highest values for structural connectivity by urban green infrastructure type were obtained in cities with Ist and IInd rank (Târgu Mureş, Oradea, Ploieşti, Iaşi) (**Error! Reference source not found.**5). The city of Băile Herculane which has its urban green infrastructure completed by forests situated at city's core area limit presents the highest connectivity degree.

The result is similar to the outcome of Total Core Area Indicator: cities where the urban green infrastructure has a low connectivity are those of III[rd] rank of small importance (ex. Odobești, Berești, Târgu Lăpuș, Negru Vodă, Isaccea).

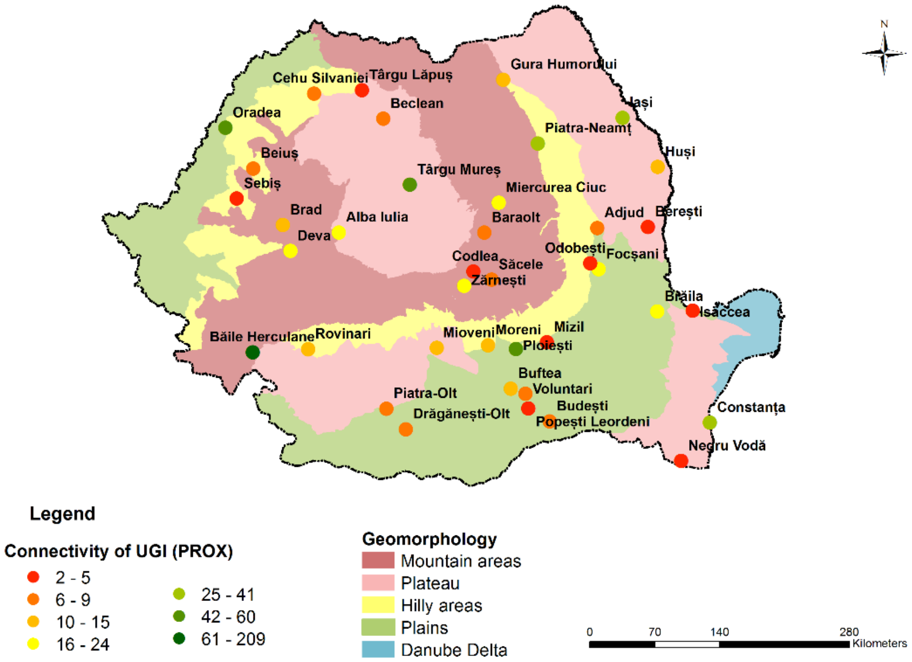


Figure 15 The distribution of Proximity indicator values in Romania's cities

Connectivity evaluation of urban parks. Case study: Bucharest

For the present analysis, the concept of functional connectivity is considered to be the residents' capacity to move between urban parks in order to satisfy their need to recreate, socialize and practice physical activities by maintaining this functions during the mobility.

An efficient instrument in raising the level of connectivity between green recreational areas could be the bicycle tracks. These are promoting a sustainable mode of transportation (Midgley, 2011) and can connect urban parks, maintaining in the same time the recreational function during the mobility.

The purpose of our analysis was to identify the criteria and suitable areas for planning of bicycle tracks which are designed to connect urban parks.

An expert-opinion based multi criteria analysis was applied in order to identify the relevant criteria for planning of bicycle tracks (Clayton, 1997). To determine the weight of each criterion specialists with expertise in urban ecology and urban green infrastructures management were chosen (Krueger et al., 2012; Iojă et al., 2014b). Through analytical hierarchy process, the selected experts compared the criteria and established a value between 1 (low importance) and 9 (high importance) based on the criteria influence on the planning of bicycle tracks (Munier, 2004). The obtained values were used as weights (Onose et al., 2015b) in a Model Builder application (ESRI, 2011) in order to map the suitable areas for bicycle tracks development. A questionnaire was applied in 34 urban parks localized in Bucharest city in order to integrate the residents' perception in the planning model for bicycle tracks. The questionnaire investigates information regarding the level of parks attractiveness for bikers, the relevant criteria and the favorable networks to plan all these aspects. For the data analysis, some descriptive statistics and spatial analysis were applied.

Both GIS analysis, based on multcriteria evaluation and on the residents' perceptions, underlined that the most suitable areas for bicycle tracks planning are the main roads which connect the residential areas with green and cultural areas.

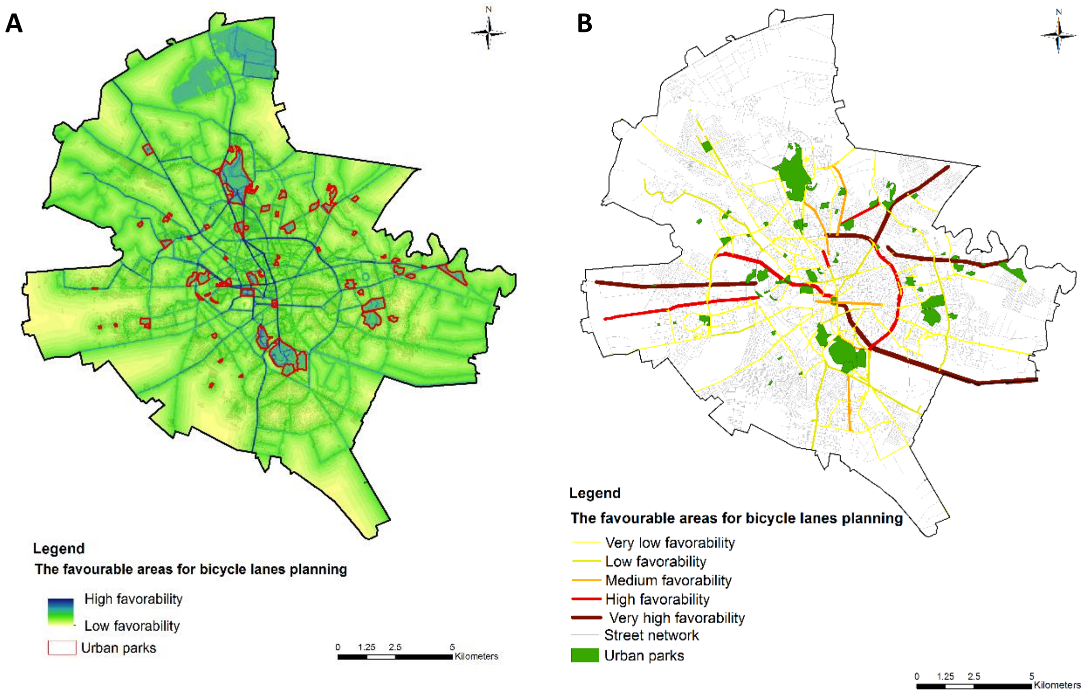


Figure 16 Suitable areas for bicycle tracks planning (A= multicriteria analysis results; B= residents' perception results)

3. Mapping the distribution of UGI in representative settlements in Romania

The data sources used for the mapping of urban green infrastructures in Romania are different based on the level of availability and the degree of details that they offer.

The orthophotoplans (www.ancpi.ro) with a national coverage have a 5 m resolution and they represent an efficient solution for the mapping of green areas at a local level. The disadvantages of aerial images consist in the high prices for their acquisition and for the long time needed for data processing.

The aerial images allow the mapping of green areas in an urban environment on different time scales. Nowadays, the availability of aerial images is high. Their disadvantage is due to the long time for processing.

Masterplans allow the mapping of green urban areas at a local level and their correlations with nearby functional areas. The reduced availability of masterplans in electronic format represents one of the disadvantages of using this type of data source.

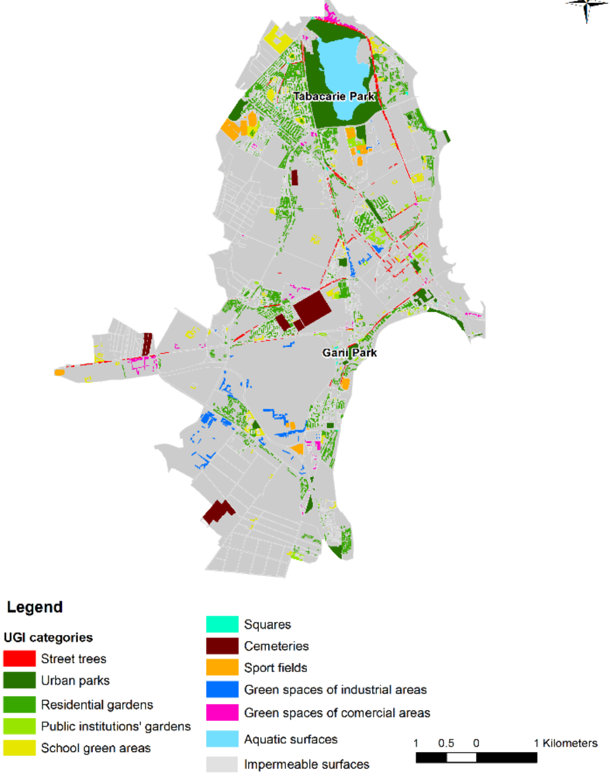
Urban Atlas is a database created at European level for the large urban areas and it includes the distribution of land use categories. Although the database permits comparison between cities, at national and European level, this has the disadvantage of a 1:10000 scale which is not sufficient for a detailed analysis.

Open street map is a free geospatial database, completed at global level, which includes land use categories, buildings distribution, road network, rivers network. Being a collaborative project, where many users edit the database, some information do not correspond to the field reality.

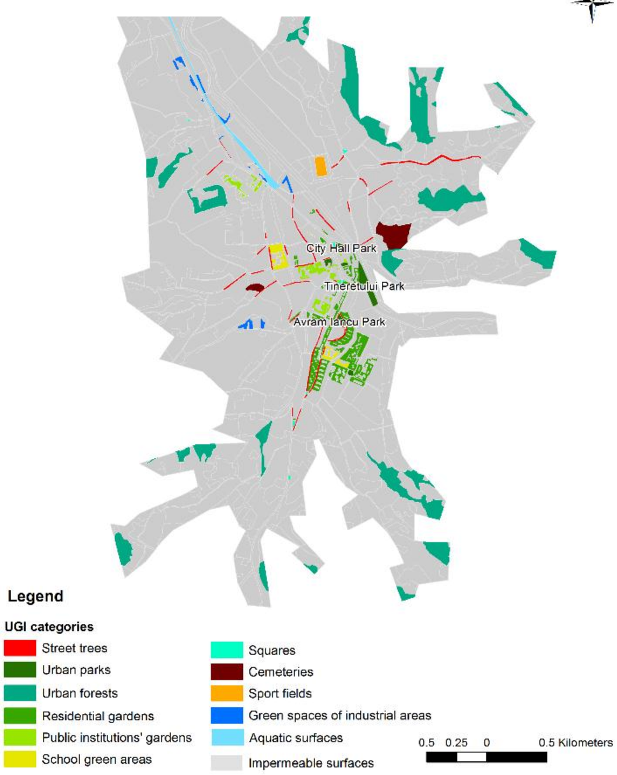
Urban green infrastructures distribution in very important cities (Rank I)

Through the analysis of the cities at a national scale, one can underline a high heterogeneity in the percentages of green areas types. The rank 1 cities present a complex network of 10 or 11 urban green infrastructures categories which include important types for the provision of ecosystem services: parks and urban forests, neighborhood gardens, schools gardens.

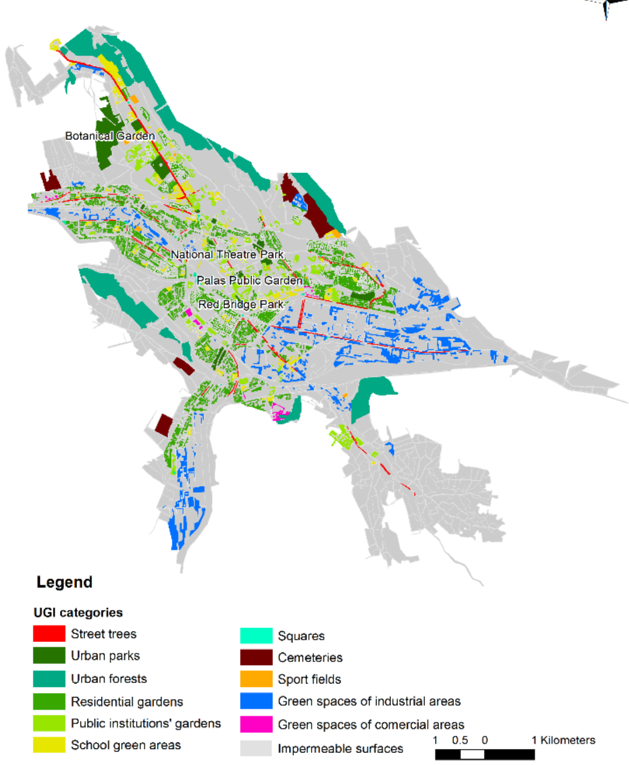
Constanța



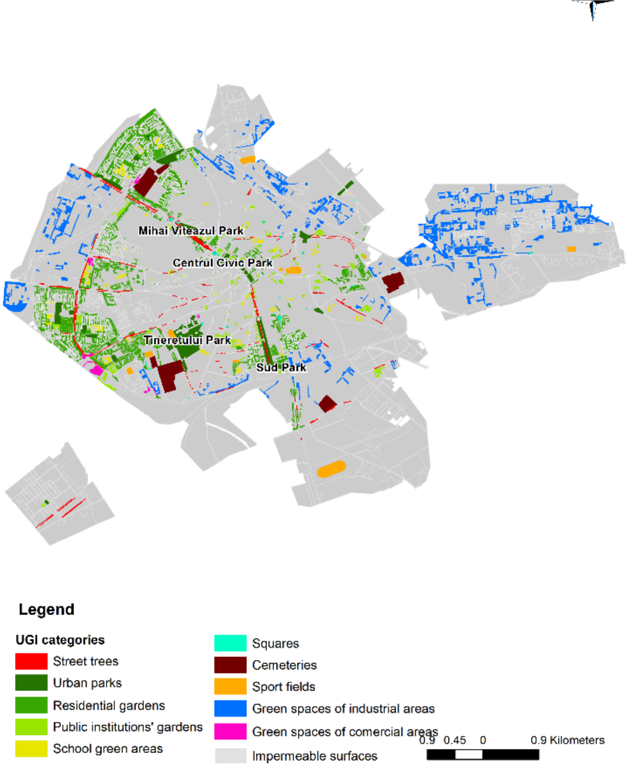
Brăila



Iași

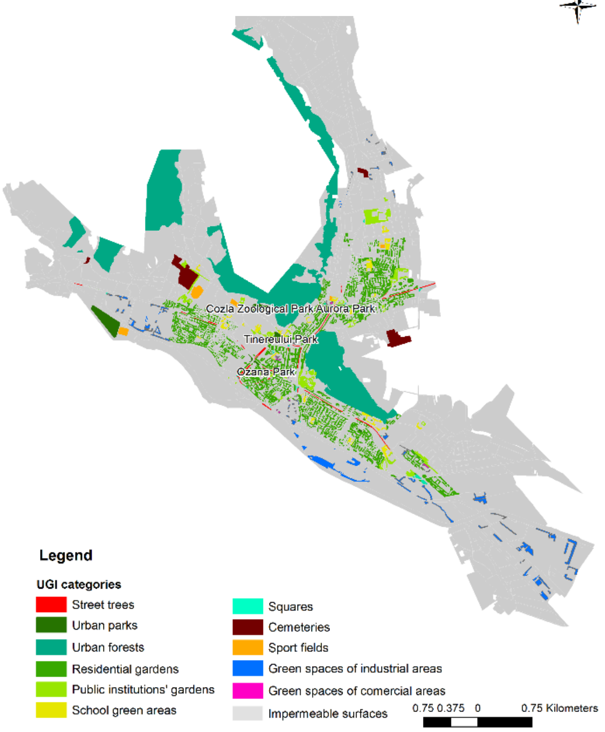


Ploiești

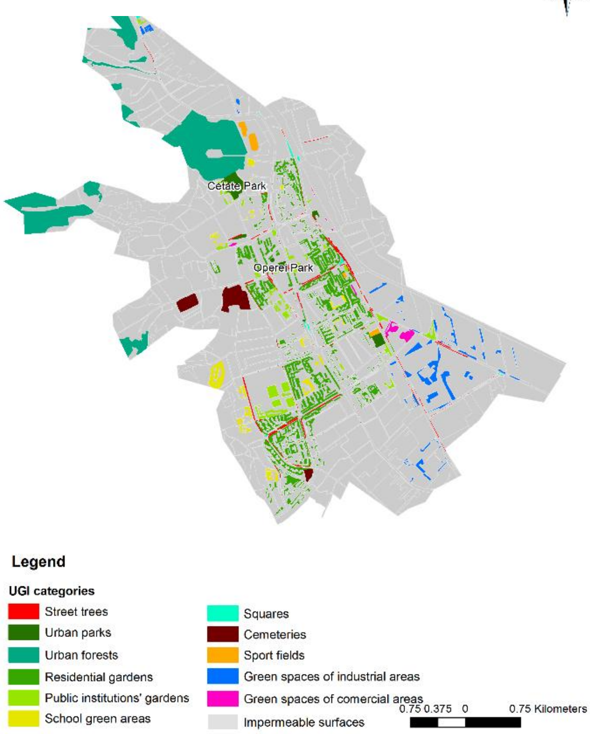


Urban green infrastructures distribution in medium importance cities (Rank II)

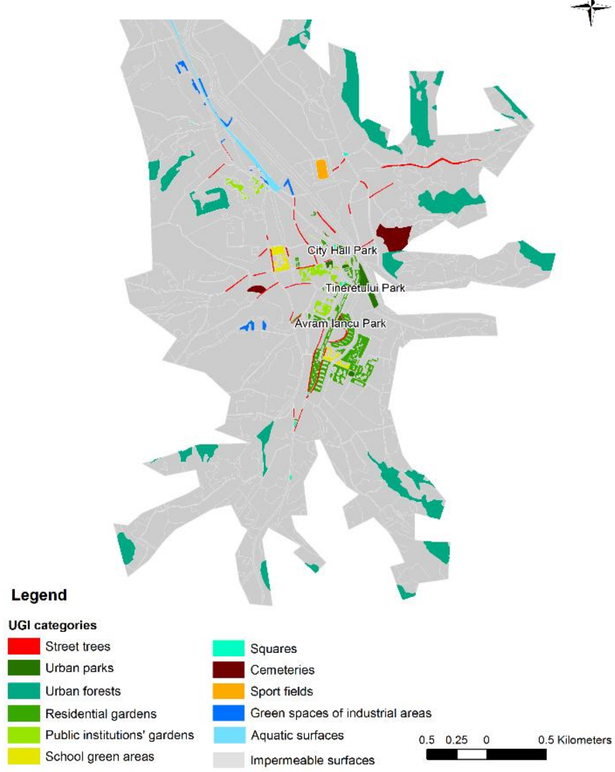
Piatra-Neamț



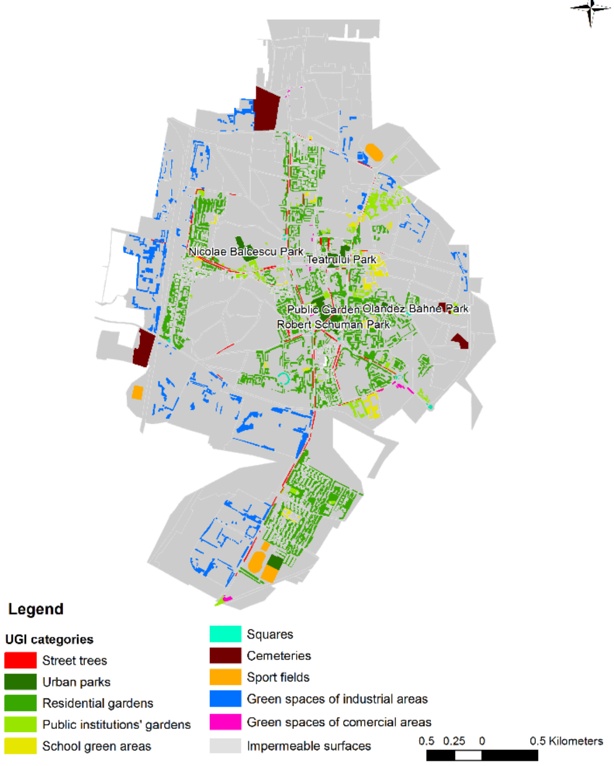
Deva



Brad



Focsani

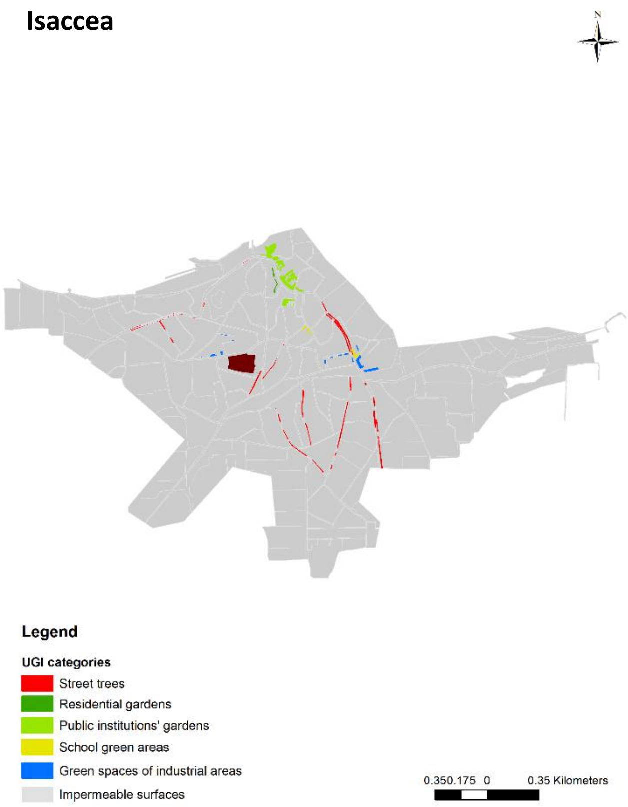


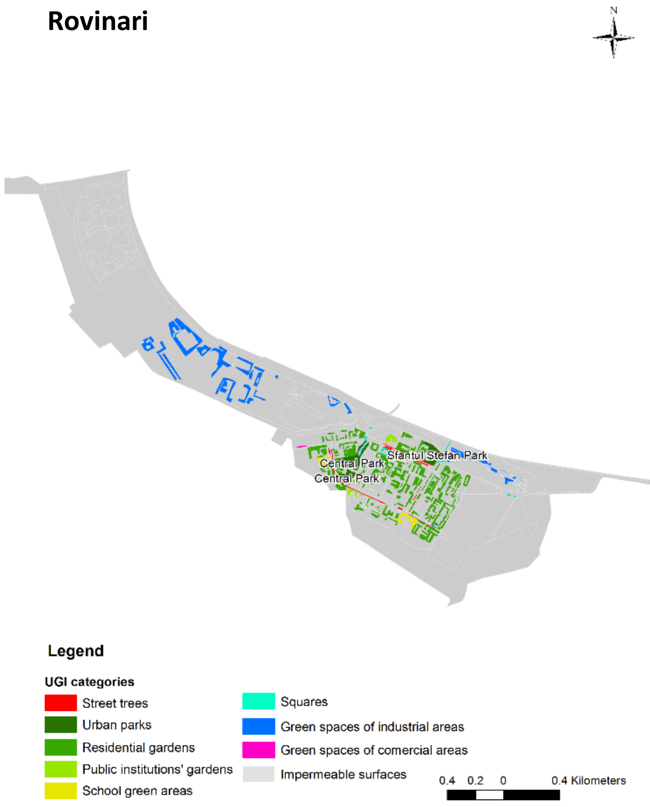
Considering medium important cities (Rank II), there are also urban green infrastructures composed of 10 or more green areas categories with much smaller urban parks than in the case of important cities.

Urban green infrastructures distribution in small importance cities (Rank III)

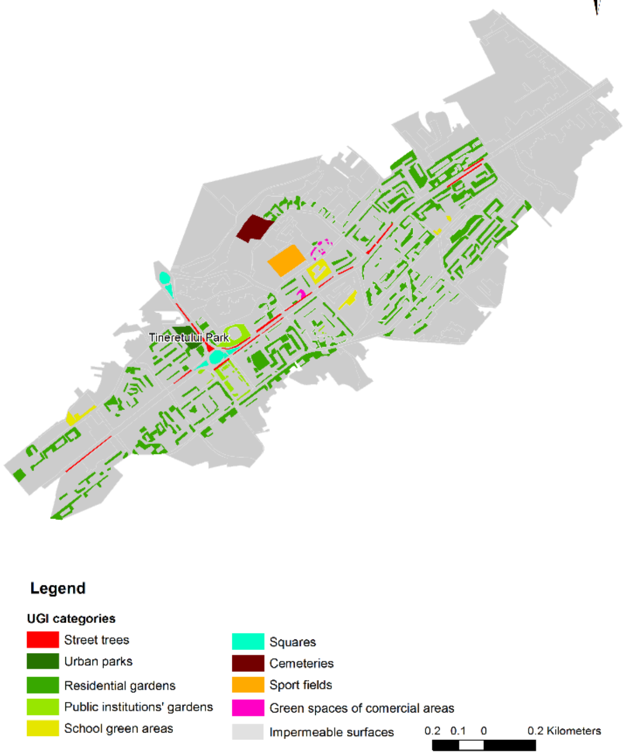
In Rank III cities, urban green infrastructure lacks some essential categories for the provision of ecosystem services and residents well-being. The ones that are missing are: urban parks, neighborhood gardens and sports fields.

The patterns of urban green infrastructures differ based on the type of relief on which the city evolved, the localization in a historical region or the period that the city was founded. A comparative analysis shows that the cities which were founded during the post-communist period and are situated in low altitudes areas present high percentages of street trees alignments (>50%) and parks (30-40%) in comparison to those that were founded in the ancient period and are situated in high lands which present a high percentage of neighborhood gardens (40-50%).

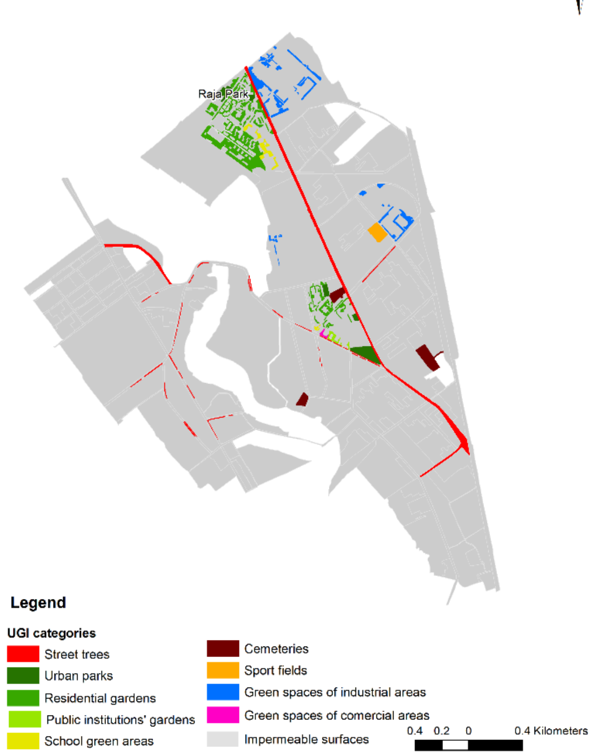




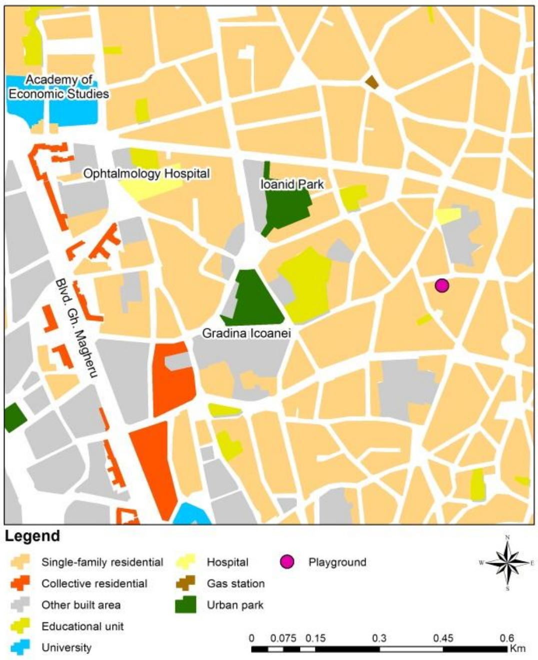
Mioveni



Buftea



Case studies at local scale



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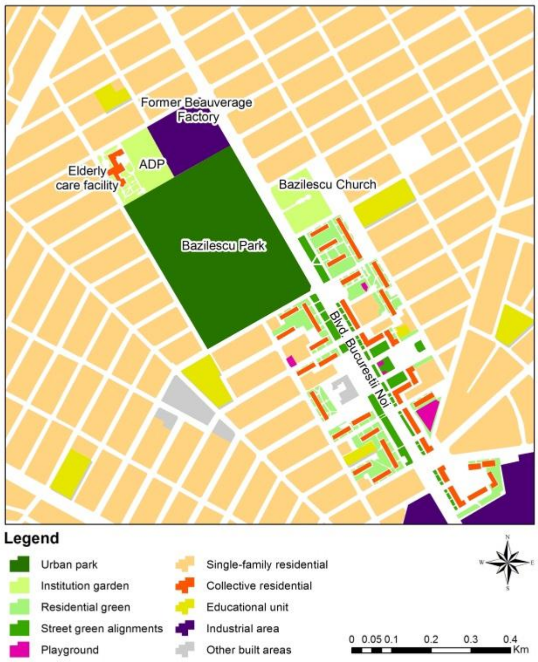
Cristiana Monastery
Capitan Serbanescu Street
Cemetery of Soviet Heroes
Legend
Institution garden
Residential green
Sports area
Cemetry
Vacant land
Playground
Single-family residential
Collective residential
Educational unit
Other built areas
0 0.05 0.1 0.2 0.3 0.4 Km


Former Beauverage Factory
Elderly care facility
ADP
Bazilescu Church
Bazilescu Park
Blvd Bucuresti Noi
Legend
Urban park
Institution garden
Residential green
Street green alignments
Playground
Single-family residential
Collective residential
Educational unit
Industrial area
Other built areas
0 0.05 0.1 0.2 0.3 0.4 Km

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4. Phase report

Published papers

Articles published in ISI databases

1. **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, doi: 10.1016/j.ecolind.2016.05.044, Factor de impact 3.190
2. **Gavrilidis, A.A., Niță, M.R., Onose, D.A., Badiu, D.L., Năstase I.I.** (under review) Methodological framework for urban sprawl control using urban green infrastructure planning, Ecological Indicators – special Issue - From urban sprawl to compact green cities – indicators for multi-scale and multi-dimensional analysis

Articles published in International Databases

1. **Gavrilidis, A.A.,** Ciocănea C.M., **Niță, M.R., Onose, D.A., Năstase I.I.,** (2016), Urban Landscape Quality Index – planning tool for evaluating urban landscapes and improving the quality of life in Procedia Environmental Sciences 32 (International Conference – Environment at a Crossroads: SMART approaches for a sustainable future), p. 155-167, http://www.sciencedirect.com/science/article/pii/S1878029616001468
2. **Gavrilidis, A.A., Niță, M.R., Onose, D.A., Năstase, I.I., Badiu, D.L.** (2016), Prioritization of Urban Green Infrastructures for Sustainable Urban Planning in Ploiesti, Romania, Real Corp 2016 Proceedings, pp. 925-929, ISBN 978-3-9504173-0-2 (CD), 978-3-9504173-1-9 (print) - http://www.corp.at/archive/CORP2016_16.pdf

Articles published in Proceedings of International Conferences

1. **Onose D.A**., Iojă, I.C., Pătru-Stupariu I., **Niță, M.R., Gavrilidis, A.A.,** Ciocanea, C.M., (2016), Analyzing the suitability of Bucharest urban parks for children related activities in Moore-Cherry, N. (2016) (eds) *Urban challenges in a complex world: Resilience, governance and changing urban systems*. Dublin: Geographical Society of Ireland, Special Publication 14. ISSN: 0791-0681 –

Abstracts published in Proceedings of International Conferences

1. **Onose, D.A., Niță, M.R., Gavrilidis, A.A., Badiu, D.L., Năstase, I.I**. (2016), Planning for children: evaluating the network of playgrounds in Bucharest, 5th International Ecosummit Ecological Sustainability, Engineering Change, Book of abstracts

2. **Năstase, I.I., Niță, M.R., Onose, D.A., Gavrilidis, A.A., Badiu, D.L.** (2016) Integrating the connectivity of urban forests in the evaluation of urban planning process in Romania, European Forum on Urban Forestry 2016, Urban forests for resilient cities, Book of abstracts
3. **Niță M.R., Onose D.A., Gavrilidis A.A., Nastase, I.I., Badiu, D.L.** (2016) A case study on the attractiveness of Urban Green Infrastructures, The 11th Edition of the International Symposium Present Environment and Sustainable Development, Book of abstracts

International conferences participations

1. **Niță M.R., Onose D.A., Gavrilidis A.A., Nastase, I.I., Badiu, D.L.** (2016) A case study on the attractiveness of Urban Green Infrastructures, International Symposium Present Environment and Sustainable Development, June 2016, Iași, Romania
2. **Năstase, I.I., Niță, M.R., Onose, D.A., Gavrilidis, A.A., Badiu, D.L.** (2016), Integrating the connectivity of urban forests in the evaluation of urban planning process in Romania, European Forum on Urban Forestry, June 2016, Ljubljana, Slovenia
3. **Gavrilidis, A.A., Niță, M.R., Onose, D.A., Năstase, I.I., Badiu, D.L.** (2016), Prioritization of Urban Green Infrastructures for Sustainable Urban Planning in Ploiesti, Romania, 21st International Conference on Urban Planning and Regional Development in the Information Society, June 2016, Hamburg, Germany
4. **Onose, D.A., Niță, M.R., Gavrilidis, A.A., Badiu, D.L., Năstase, I.I.,** (2016), Planning for children: evaluating the network of playgrounds in Bucharest, 5th International Ecosummit Ecological Sustainability, Engineering Change, 29 August – 2 September, Montpellier, France;
5. **Badiu, D.L.,** Pătroescu, M., **Gavrilidis, A.A., Onose, D.A., Niță, M.R.** (2016), Assessing the distribution of green infrastructures in Romanian cities, 3th International SURE Workshop: Nature Conservation and Urban Development – How to manage together?, September 2016, Bucharest, Romania
6. **Niță, M.R., Năstase, I.I., Badiu, D.L., Onose, D.A., Gavrilidis, A.A.** (2016), Evaluating the relationship between urban forest location and urban functions in Romanian cities from Carpathian region, The 4th International Conference Forum Carpaticum – Future of the Carpathians: Smart, Sustainable, Inclusive, 28-30 September 2016, Bucharest, Romania;
7. **Niță, M.R., Gavrilidis, A.A., Onose, D.A., Badiu, D.L., Năstase, I.I.** (2016), Urban green infrastructure planning in Romania integrating the perception of experts and local actors, International Conference Re-shaping Territories Environment and Societies: New Challenges for Geography, November 2016, Bucharest, Romania;
8. **Badiu, D.L., Niță, M.R.,** Pătroescu, M. (2016), Indicators evaluating the benefits of urban green infrastructures in representative case studies from Romania, International Conference Re-shaping Territories Environment and Societies: New Challenges for Geography, November 2016, Bucharest, Romania;
9. **Gavrilidis, A.A.,** Avram, M., **Niță, M.R.,** Niculae, I.M., Vânău, G.O., **Onose, D.A., Badiu, D.L.**, Ciocănea, C.M., Iojă, C.I., Pătroescu, M. (2016), Categories of oxygen-generating surfaces in Romanian cities – their place and role in urban landscapes, International Conference Re-shaping Territories Environment and Societies: New Challenges for Geography, November 2016, Bucharest, Romania;

National conference participation

1. **Niță, M.R.,** Patroescu M., **Gavrilidis A.A., Onose D.A.** (2016), *Evaluarea locului si rolului infrastructurilor verzi in dezvoltarea urbana durabila*, Sesiunea anuala de Comunicari dedicata aniversarii a 150 de ani de la infiintarea Academiei Romane – Geografia romaneasca in context European, 1 July, Bucharest, Romania.

<u>Research-documentation stages and training activities</u>

1. **Formation stage Amsterdam – Niță Mihai Răzvan**

Location: Institute for Environmental Studies, VU University Amsterdam - Department Spatial Analysis and Decision Support
Period: 18-24 September 2016
Objectives: Exchange of good practices in the field of spatial analysis applied in urban areas, visiting some examples of green infrastructure implementation in Holland.

2. **Formation stage Bari – Badiu Denisa Lavinia**

Location: University of Bari Aldo Moro – Department of Agro-environmental and Regional Sciences, Bari, Italy
Period: 23-29 October 2016
Objectives: During the formation stage potential collaborations in the field of urban green infrastructures research were discussed and efforts were directed towards the elaboration of a scientific article. Also, there were discussions about the Workshop related with planning green infrastructures in urban areas that will be organized in July 2017.

3. **Conference participation** New Pressures on Cities and Regions**: Gavrilidis Athanasios Alexandru**

Location: London
Organizer: Regional Studies Association. The Global Forum for City and Regional Research, Development and Policy
Period: 24 – 25 November 2016
Objectives: Identifying new theoretical, methodological and practical approaches in the management of urban areas in the framework of current threats to the quality of life.

4. **Course Statistics – Badiu Denisa Lavinia**

Denisa Badiu, member of the research team, participated in the online course ***Statistics 1-Probability and Study Design***, organized by ***The Institute for Statistics Education.*** The course had a length of one month. Through the course participation Denisa Badiu founded her knowledge related with basic statistical concepts.

5. **Course GIS – Gavrilidis Athanasios Alexandru**

For a period of 6 weeks Gavrilidis Athanasios Alexandru, member of the research team, attended the online course of Spatial Analysis organized by University of Oxford – Department of Continuing Education. The course topic was Introducing Mapping, Spatial Data & GIS. He developed the skills related with using spatial databases and cartography using GIS solutions.

References

Amorim, L.M.E, Filho M.N.M.B, Cruz, D. (2014) *Urban texture and space configuration: An essay on integrating socio-spatial analytical techniques*, Cities 39, 58-67
Barlam, S., & Dragicevic, S. (2005). Attitudes toward urban green spaces: integrating questionnaire survey and collaborative GIS techniques to improve attitude measurements. *Landscape and Urban Planning, 71*, 147–162.
Cameron, R. W. F., Blanusa, T., Taylor, J. E., Salisbury, A., Halstead, A. J., Henricot, B., & Thompson, K. (2012). The domestic garden – Its contribution to urban green infrastructure. *Urban Forestry & Urban Greening, 11*, 129-137.
Cârstea, M. (2008). Ways and means of evaluation of the perception of the urban environment condition. *Present Environment and Sustainable Development, 2*.
Carter, J. G. (2011). Climate change adaptation in European cities. *Current opinion in environmental sustainability, 3*(3), 193-198.
Chelcea, S. (2007). *Metodologia cercetarii sociologice: metode cantitative si calitative*: Editura Economică.
Chiesura, A. (2004). The role of urban parks for the sustainable city. *Landscape and Urban Planning, 68*, 129-138.
Cicea, C., & Pirlogea, C. (2011). Green spaces and public health in urban areas. *Theoretical and Empirical Researches in Urban Management, 6*(1), 83.
Ciocănea, C. M. (2013). *Ph.D.* Ph.D. Ph.D., Universitatea din București, București.
Clayton, M. J. (1997). Delphi: a technique to harness expert opinion for critical decision making tasks in education. *Educational Psychology, 17*(4), 373-386.
Conrad, E., Christie, M., & Fazey, I. (2011). Understanding public perceptions of landscape: a case study from Gozo, Malta. *Applied Geography, 31*(1), 159-170.
Cornelis, J., & Hermy, M. (2004). Biodiversity relationships in urban and suburban parks in Flanders. *Landscape and Urban Planning, 69*(4), 385-401.
Crooks, K. R., & Sanjayan, M. (2006). Connectivity conservation: maintaining connections for nature. *Conservation Biology Series - Cambridge, 14*(1), 1-10.
Cucu, A., Ciocănea, C. M., & Onose, D. A. (2011). Distribution of Urban Green Spaces - an indicator of topophobia - topophilia of urban residential neighborhoods. Case Study of 5th District of Bucharest, Romania. *Forum geografic. Studii și cercetări de geografie și protecția mediului 10*(2), 276 – 286.
Cvejić, R., Eler, K., Pintar, M., Železnikar, Š., Haase, D., Kabisch, N., & Strohbach, M. (2015). A typology of urban green spaces, ecosystem services provisioning services and demands (Vol. 10): Helsingin Yliopisto, Univerza v Ljubljana, Humboldt Universität zu Berlin, Technische Universität München, Stockholms Universitet, Forestry Commission Research Agency, Fundação da Faculdade de Ciências Da Universidade de Lisboa.
Dige, G. (2011). Green infrastructure and territorial cohesion. The concept of green infrastructure and its integration into policies using monitoring systems: Technical Report 18. European Environment Agency, Copenhagen, Denmark.[online] URL: http://www. eea. europa. eu/publications/green-infrastructure-and-territorial-cohesion.
Dunn, R. R. (2010). Global mapping of ecosystem disservices: the unspoken reality that nature sometimes kills us. *Biotropica, 42*(5), 555-557.
EEA. (2012). *Urban adaptation to climate change in Europe. Challenges and opportunities for cities together with supportive national and European policies.* . Copenhagen: European Environment Agency.
Escobedo, F. J., Kroeger, T., & Wagner, J. E. (2011). Urban forests and pollution mitigation: Analyzing ecosystem services and disservices. *Environmental pollution, 159*(8), 2078-2087.
ESRI. (2011). Geoprocessing with ModelBuilder. *ArcGIS Resource Center*.
European Commission. (2010). Survey on perception of quality of life in 75 European cities: Directorate generale Regional Policy - European Commision.
European Commission. (2012). *The Multifunctionality of Green Infrastructure*. Bruxelles.
Foltête, J. C., Girardet, X., & Clauzel, C. (2014). A methodological framework for the use of landscape graphs in land-use planning. *Landscape and Urban Planning, 124*(140-150).
Forman, R. T. T. (2006). *Land Mosaics, The ecology of landscapes and regions*. Cambridge, United Kingdom: Cambridge University Press.
Gill, S. E., Handley, J. F., Ennos, A. R., & Pauleit, S. (2007). Adapting cities for climate change: the role of the green infrastructure. *Built environment, 33*(1), 115-133.
Grădinaru, S. R., Iojă, C. I., Onose, D. A., Gavrilidis, A. A., Pătru-Stupariu, I., Kienast, F., & Hersperger, A. M. (2015). Land abandonment as a precursor of built-up development at the sprawling periphery of former socialist cities. *Ecological Indicators, 57*, 305-313.
Hobbs, E. R. (1988). Species richness of urban forest patches and implications for urban landscape diversity. *Landscape Ecology, 1*(3), 141-152.
Hofmann, M., Westermann, J. R., Kowarik, I., & van der Meer, E. (2012). Perceptions of parks and urban derelict land by landscape planners and residents. *Urban Forestry & Urban Greening, 11*(3), 303-312.
Hostetler, M., Allen, W., & Meurk, C. (2011). Conserving urban biodiversity? Creating green infrastructure is only the first step. *Landscape and Urban Planning, 100*(4), 369-371.
Ianoș, I. (2004). *Dinamica urbană. Aplicatii la orașul și sistemul urban românesc*. București: Edit. Tehnică.

Iojă, C., Grădinaru, S. R., Onose, D. A., Vânău, G. O., & Tudor, A. C. (2014a). The potential of school green areas to improve urban green connectivity and multifunctionality. *Urban Forestry & Urban Greening, 13*(4), 704-713.
Iojă, C., Pătroescu, M., Niţă, M., Rozylowicz, L., Iojă, A., & Onose, D. A. (2010). Categories of residential spaces after their accessibility to urban parks - an indicator of sustainability in human settlements *Wseas Transactions on Environment and Development, 5*(6), 307-314.
Iojă, C. I., Niţă, M. R., Vânău, G. O., Onose, D. A., & Gavrilidis, A. A. (2014b). Using multi-criteria analysis for the identification of spatial land-use conflicts in the Bucharest Metropolitan Area. *Ecological Indicators, 42*, 112–121.
Iojă, C. I., Niţă, M. R., Vânău, G. O., Onose, D. A., Gavrilidis, A. A., & Hossu, A. C. (2015). *Managementul conflictelor de mediu*. Bucureşti.
Iojă, C. I., Rozylowicz, L., Pătroescu, M., Niţă, M. R., & Vânău, G. O. (2011). Dog walkers' vs. other park visitors' perceptions: The importance of planning sustainable urban parks in Bucharest, Romania. *Landscape and Urban Planning, 103*, 74-82.
Ioja, I., Onose, D., Nita, M., Vanau, G., Patroescu, M., Gavrilidis, A., Saghin, I., & Zarea, R. (2011). The conversion of agricultural lands into built surfaces in Romania. *Recent Researches in Urban Sustainability and Green Development, 6*, 115-120.
Jabareen, Y. (2013). Planning the resilient city: Concepts and strategies for coping with climate change and environmental risk. *Cities, 31*, 220-229.
Jaeger, J.A.G, Bertiller, R., Schwick, C., Cavens, D., Kienast, F. (2010) *Urban permeation of landscapes and sprawl per capita: New measures of urban sprawl*, Ecological Indicators 10, 427-441
Jim, C., & Chen, W. Y. (2006). Perception and attitude of residents toward urban green spaces in Guangzhou (China). *Environmental management, 38*(3), 338-349.
Kadoya, T. (2009). Assessing functional connectivity using empirical data. *Population Ecology, 51*, 5-15.
Kindlmann, P., & Burel, F. (2008). Connectivity measures: a review. *Landscape ecology, 23*(8), 879-890.
Kong, F., & Nakagoshi, N. (2006). Spatial-temporal gradient analysis of urban green spaces in Jinan, China. *Landscape and urban Planning, 78*(3), 147-164.
Kupfer, J. A. (2012). Landscape ecology and biogeography: Rethinking landscape metrics in a post-FRAGSTATS landscape. *Progress in Physical Geography, 36*(3), 400–420.
Lyytimäki, J., Petersen, L. K., Normander, B., & Bezák, P. (2008). Nature as a nuisance? Ecosystem services and disservices to urban lifestyle. *Environmental sciences, 5*(3), 161-172.
Marulli, J., & Mallarach, J. M. (2005). A GIS methodology for assessing ecological connectivity: application to the Barcelona Metropolitan Area. *Landscape and Urban Planning, 71*, 243-261.
McGarigal, K. (2014). FRAGSTATS help Amherst (Ed.)
McPherson, G., Simpson, J.R.,, Peper, P. J., Maco, S. E., & Xiao, Q. (2005). Municipal forest benefits and costs in five US cities. *Journal of Forestry, 103*(8), 411-416.
McRae, B. H., Dickson, B. G., Keitt, T. H., & Shah, V. B. (2008). Using circuit theory to model connectivity in ecology, evolution, and conservation. *Ecology, 89*(10), 2712-2724.
Mentens, J., Raes, D., & Hermy, M. (2006). Green roofs as a tool for solving the rainwater runoff problem in the urbanized 21st century? *Landscape and Urban Planning, 77*, 217-226.
Moilanen, A., Kujala, H., & Leathwick, J. R. (2009). The Zonation framework and software for conservation prioritization. *Spatial conservation prioritization, 196-210*.
Nedelciu, E., Peicea, D., & Kotulak, M. (2013). Enriching our society thorugh natural solutions. Why an how to make Green infrastructure projects a sustainable answer for ecological, social and economic problems. In A. Zolyomi (Ed.): CEEweb for Biodiversity & European Centre for Nature Conservation.
Niculae, M. I., Niţă, M. R., Vânău, G. O., & Pătroescu, M. (2016). Evaluating the Functional Connectivity of Natura 2000 Forest Patch for Mammals in Romania. *Procedia Environmental Sciences, 32*(28-37).
Niţă, M. R. (2016). *Infrastructuri Verzi - o abordare geografică*. Bucureşti, România: Editura Etnologică.
Onose, D.-A., Niţă, M. R., Ciocănea, C. M., Pătroescu, M., Vânău, G. O., & Bodescu, F. (2015a). Identifying Critical Areas Of Exposure To Environmental Conflicts Using Expert Opinion And Multi-Criteria Analysis. *Carpathian Journal of Earth and Environmental Sciences, 10*(4), 15-28.
Onose, D. A., Niţă, M. R., Ciocănea, C. M., Pătroescu, M., Vânău, G. O., & Bodescu, F. P. (2015b). Identifying Critical Areas Of Exposure To Environmental Conflicts Using Expert Opinion And Multi-Criteria Analysis. *Carpathian Journal of Earth and Environmental Sciences, 10*(4), 15-28.
Ozer, E. J. (2006). The Effects of school gardens on students and schools: conceptualization and considerations for maximizing healthy development. *Health Education & Behavior, 34* (6), 846-863.
Patroescu, M., Iojă, C., Necsuliu, R., & Brăilescu, C. (2004). The quality of oxygenating surfaces. The green areas of Bucharest. A case studies. *Revue Roumaine de Geographie, 47-48*, 205-216.
Priego, C., Breuste, J., & Rojas, J. (2008). Perception and value of nature in urban landscapes: a comparative analysis of cities in Germany, Chile and Spain. *Landscape Online, 7*(1), 22.
Puertas, O.L., Henriquez, C., Meza, F.J. (2014) *Assesing spatial dynamics of urban growth using an integrated land use model. Application in Santiago Metropolitan Area, 2010-2045*, Land Use Policy 38, 415-425

Pulighe, G., Fava, F., & Lupia, F. (2016). Insights and opportunities from mapping ecosystem services of urban green spaces and potentials in planning. *Ecosystem Services, 22*, 1-10.
Qureshi, S., Hasan Kazmi, S. J., & Breuste, J. H. (2010). Ecological disturbances due to high cutback in the green infrastructure of Karachi: Analyses of public perception about associated health problems. *Urban Forestry & Urban Greening, 9*(3), 187-198.
Rocha, S. M., Zulian, G., Maes, J., & Thijssen, M. (2015). Mapping and assessment of urban ecosystems and their services: Joint Research Centre.
Saghin, I., Ioja, C., Gavrilidis, A., Cercleux, L., Niţă, M., & Vânău, G. (2012). *Perception of the Industrial Areas Conversion in Romanian Cities-Indicator of Human Settlements Sustainability.* Paper presented at the 48th ISOCARP Congress, Perm, Russia.
Salvati, L. (2014) *Land availability vs conversion bz use type: A new approach for land take monitoring*, Ecological Indicators 36, 221-223
Saura, S., & Torne, J. (2009). Conefor Sensinode 2.2: a software package for quantifying the importance of habitat patches for landscape connectivity. *Environmental Modelling & Software, 24*(1), 135-139.
Schipperijn, J., Ekholm, O., Stigsdotter, U. K., Toftager, M., Bentsen, P., Kamper-Jørgensen, F., & Randrup, T. B. (2010). Factors influencing the use of green space: Results from a Danish national representative survey. *Landscape and Urban Planning, 95*(3), 130-137.
Stanilov, K. (2007). Urban planning and the challenges of the post-socialist transformation *The Post-Socialist City* (pp. 413-425): Springer.
Swanwick, C., Dunnett, N., & Woolley, H. (2003). Nature, role and value of green space in towns and cities: An overview. *Built Environment, 29*(2), 94-106.
Sýkora, L., & Ourednek, M. (2007). Sprawling post-communist metropolis: Commercial and residential suburbanization in Prague and Brno, the Czech Republic *Employment Deconcentration in European Metropolitan Areas* (pp. 209-233): Springer.
Takano, T., Nakamura, K., & Watanabe, M. (2002). Urban residential environments and senior citizens' longevity in mega-city areas: the importance of walkable green space. *Journal of Epidemiology & Community Health, 56*, 913–916.
Taylor, P. D., Fahrig, L., Henein, K., & Merriam, G. (1993). Connectivity is a vital element of landscape structure. *Oikos, 68*, 571-573.
Thompson, C. W., Roe, J., & Aspinall, P. (2013). Woodland improvements in deprived urban communities: What impact do they have on people's activities and quality of life? *Landscape and Urban Planning, 118*, 79-89.
Urban, D., & Keitt, T. (2001). Landscape connectivity: a graph-theoretic perspective. *Ecology, 82*(5), 1205-1218.
Wolch, J., Jerrett, M., Reynolds, K., McConnell, R., Chang, R., Dahmann, N., Brady, K., Gilliland, F., Su, J. G., & Berhane, K. (2011). Childhood obesity and proximity to urban parks and recreational resources: A longitudinal cohort study. *Health & Place, 17*, 207–214.
Yang, J., Yu, Q., & Gong, P. (2008). Quantifying air pollution removal by green roofs in Chicago. *Atmospheric environment, 42*(31), 7266-7273.
Zhang, H., Chen, B., Sun, Z., & Bao, Z. (2013). Landscape perception and recreation needs in urban green space in Fuyang, Hangzhou, China. *Urban Forestry & Urban Greening, 12*(1), 44-52.