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Is urban green space per capita a valuable target to achieve cities' sustainability goals? Romania as a case study

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ABSTRACT

Urban green infrastructure is considered to be a key element in improving quality of life and creating an appropriate framework for sustainable cities. The most used quantitative indicator to assess urban green infrastructure is urban green space (UGS) per capita. This paperís aim is to analyze whether UGS is a valuable target to achieve cities' sustainability goals. We used Romania as a case study, which should meet the target of 26 m^2 of UGS per inhabitants in all cities. Aerial images were used to extract the surface of the UGS categories for a sample of 38 cities in Romania. We compared our data with three other databases (National Institute of Statistics, Environmental Protection Agencies and Urban Atlas) to check for differences. To understand the contribution of geographic and socio-economic factors to the dynamic of the UGS per capita in Romania's cities, we used a multiple linear regression. To identify differences between cities in terms of their proportions of UGS, multiple correspondence analysis was performed. We found significant differences between the surface of UGS reported by the administrative offices and that resulting from the spatial analysis. The process of reporting UGS data currently has methodological and perspective shortcomings. Moreover, the density of the built-up space, the proximity to major transport infrastructure, the cities' founding period and the geomorphology criteria are important predictors for the UGS. The target of 26 m^2 of green area per inhabitant in all Romanian cities is not feasible and it should consider the cities' characteristics, if you want to achieve sustainability goals. Urban green planning should focus more on the development of urban green infrastructure models that are adapted to each type of urban area.

1. Introduction

Urban green infrastructure is the cornerstone of the sustainable development of urban systems (James et al., 2009). There are several definitions on the concept of green infrastructure but the key features are referring to a "(. . .) a strategically planned network of high quality natural and semi-natural areas with other environmental features, which is designed and managed to deliver a wide range of ecosystem services and protect biodiversity in both rural and urban settings." (European Commission, 2013).

The urban green infrastructure categories vary by structure and are defined by their surface and functions (European Commission, 2012). Comprehensive approaches have emphasized on the importance of public accessibility of urban green spaces (UGS) with differences between private, public or semi-public management (Cvejić et al., 2015). Categories that are accessible and provide benefits to the large public are: parks (e.g. provide space for recreation and contribute to noise reduction) (Bolund and Hunhammar, 1999), street trees (e.g. improve the air quality and provide habitat for species) (DeGraaf and Wentworth, 1986), school green areas, public institutions' gardens, residential gardens, cemeteries, sports grounds, squares (e.g. which contributes to rainwater drainage and micro-climate regulation) (De Ridder et al., 2004), urban forests (e.g. provide habitat for wildlife) (Hobbs, 1988), as well as the green spaces of the industrial and commercial production. There are other categories of green infrastructure categories, but many

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of them are not considered in the planning process in some east European countries, such as green roofs, vertical gardens (Alexandri and Jones, 2008), arable lands, vacant land (European Environment Agency, 2011) and greenhouses (Iojă et al., 2014a) or permeable pavements (Scholz and Grabowiecki, 2007). Even so, UGS is the main component of urban green infrastructure.

UGS is important to the urban community (Breuste et al., 2015; Kabisch et al., 2014) for the improvement of life quality because it is a crucial supplier of urban ecosystem services (Lafortezza et al., 2013; Tratalos et al., 2007). Filtration of air pollutants and improvement of air quality (Bolund and Hunhammar, 1999), local climate regulation (Bastian et al., 2012), nature experience, recreation, sport activities (Chiesura, 2004) and storm water runoff control (Breuste et al., 2013) are relevant urban ecosystem services provided by UGS.

In the context of the Rio + 20 UN Conference on Sustainable Development, the development of UGS is considered an important indicator of sustainability in cities because it contributes to human health and wellbeing. The relevance of UGS for sustainability and safe living is also explained by the presence of indicators of urban green space in official documents (i.e., 100 Global Monitoring Indicators Complementary National Indicators, 2030 Agenda for Sustainable Development).

The basic methodological approaches for UGS are related to its quantitative analysis features, using, for example, landscape metrics (Kong and Nakagoshi, 2006), linear indicators for tree cover analysis (Cornelis and Hermy, 2004; Landry and Chakraborty, 2009) or statistical methods (Kabisch and Haase, 2013). Studies regarding the quality of UGS were centered on the provision of socio-cultural benefits (Mell, 2010; Tzoulas and James, 2010) and their importance towards biodiversity conservation in urban ecosystems (Carrus et al., 2015). The pattern and structure of UGS were analyzed in regard to the categories included in the network and what functions they fulfil (Landscape Institute, 2010). Because the concept of multi-functionality can be related to the provision of ecosystem services, studies regarding this subject have thrived (Tzoulas et al., 2007).

Even though the studies undertaken so far provide a clear image of the importance of UGS, more effort is necessary to improve the protection and (re-)development of UGS (Artmann, 2015; Kabisch and Haase, 2013). There is also a lack of information regarding the feasibility and suitability of the targets of UGS per capita. In addition to the studies that analyze the supply or targets to be met in terms of UGS (Fuller and Gaston, 2009; Kabisch and Haase, 2013), there is a need to understand whether these targets can be universally applied or should be applied in accordance to cities' characteristics.

The supply of UGS in European cities varies by state, from approximately 4 m^2 per capita in the cities of Spain, Macedonia and southern Italy, to 200 m^2 per capita in the cities of Germany, Belgium and Austria (Fuller and Gaston, 2009). Some examples of green supply in cities are: in Linz, Austria the green space ratio is 27.14 m^2 per capita (Hansen et al., 2015), in Helsinki, Finland the ratio is 25.51 m^2 per capita (Vierikko et al., 2015) and in Amsterdam, The Netherlands, the ratio is 17.62 m^2 per capita (Havik et al., 2015).

As Fuller and Gaston 2009 state, the surface of green spaces per capita increases with latitude, and larger areas of green spaces characterize the cities from northern and central Europe. According to the authors, the variation can be explained by the size of the city (i.e., high values of urban green in large cities) and population density (i.e., high densities of population are correlated with low surfaces of urban green area).

Beyond the supply, several studies were conducted to identify the targets regarding UGS. The World Health Organization has set a minimum target of 9 m^2 and an ideal value of 50 m^2 of UGS per capita (World Health Organization, 2010), whereas European cities have different targets regarding the minimum surface of UGS per capita. In German cities, targets related to green supply per capita vary between 6 and 15 m^2 per resident (für Landespflege, 2006). The residents from a large city, such as Berlin, should have access to UGS of a minimum of 0.5 ha at a distance of 500 m from their residence and to 6 m^2 of UGS per capita (Kabisch et al., 2015).

The problematic aspect of the UGS per capita is that it does not take into account the characteristics of cities, the socio-economical and landscape traits or the structure of the UGS. Regardless of the surface, UGS can ensure the needs of the inhabitants (i.e., for recreation or other activities) by including certain categories of UGS. Although it is used in many European cities, this indicator does not specify the categories considered or excluded from the evaluation.

The UGS structure (i.e.% of different categories of UGS) can provide information about the deficit of certain categories of UGS, which will help the planning system to respond to residents' needs regarding different types of UGS (e.g., residential gardens, school green areas and parks) for different physical or recreational activities.

Although a range of studies that quantify UGS exist, there is a lack of analyses on the structural pattern and drivers. For instance, a temporal analysis of the development of UGS in European cities showed that a decrease in urban population does not automatically support an increase in UGS on a large scale (Kabisch and Haase, 2013). In terms of spatial drivers, Fuller and Gaston, 2009 found in a study of the distribution of green spaces in 300 European cities that the drivers are linked more to the city area than to the number of residents. Another driving factor considered for urban green areas in European countries is the historical period. In London, for example, the medieval common lands are now an important part of the urban green infrastructure (Venn and Niemela, 2004).

Additionally, the greater importance the residents attach to UGS, the higher the proportion it will occupy within the urban environment (Sanesi and Chiarello, 2006). The consumption patterns of land take can influence the density of built-up areas in the urban environment, which means more or less space for UGS (Davies et al., 2008). Residents living in highly sealed and built-up areas lack access to UGS, influencing the supply of ecosystem services and the living quality according to the residentsí demands (Artmann, 2013; Artmann and Breuste, 2015).

The cultural background of a city drives the use, perception and values of UGS, but a high variability of UGS per capita cannot be attributed to the cultural diversity of the urban residents (James et al., 2009).

In post-socialist countries, such as Romania, urban green spaces have decreased as a result of the changes in land management, industrial reconversion, restitution of private lands and the informal aspect of urban planning (Iojă, 2009). According to the national legislation, Romania established to increase the UGS ratio up to 26 m^2 per capita by 2015, in all cities, regardless of their characteristics (Romanian Parliament, 2013).

The importance of our study is supported by the lack of information on the quantity, structure and determinants of UGS. There is a need on detailed information on the driving factors of urban green distribution in Romanian cities and development to support an effective management of the spaces, especially in cities with shortage of urban green spaces. In addition, it is important to understand the drivers that can affect UGS, in order to mitigate the negative effect and to increase the potential of ecosystem services (Grimm et al., 2008; Larondelle et al., 2014).

Although the necessity of having green registers (i.e., qualitative and quantitative statistics on urban green areas) for Romania's cities has been incorporated into the national legislation since 2007, they are not yet finalized. The means for assessing UGS in Romania are not clearly established, and the achievement of the target cannot be monitored.