LONG TERM DYNAMIC OF URBAN GREEN SPACES IN ROMANIA

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Abstract. Urban green spaces are important for their contribution to urban welfare, sustainability and resilience though the ecosystem services provided. However, in Romania, as in other developing countries, green spaces were neglected, and the planning policies aimed at protecting and expanding the green infrastructure were not enforced. As a consequence, this study aimed at looking at the long-term dynamic of Romanian urban green spaces using geospatial data. The results indicated that the green spaces were lost and fragmented, reclaiming immediate action on behalf of city managers and public authorities.

Keywords: urban planning, spatial planning, green infrastructure, ecosystem services, urban sustainability, urban ecology.

Rezumat. Dinamica spaţiilor verzi în România pe termen lung. Prin serviciile ecosistemice oferite, spaţiile verzi sunt importante prin prisma contribuţiei la bunăstarea, dezvoltarea durabilă şi rezilienţa oraşelor. Cu toate acestea, în România, ca şi în alte ţări în curs de dezvoltare, spaţiile verzi au fost neglijate, iar reglementările urbanistice ce vizează protecţia şi extinderea lor nu au fost implementate. În consecinţă, studiul de faţă a urmărit să analizeze dinamica pe termen lung a spaţiilor verzi în România pe baza datelor geo-spaţiale. Rezultatele indică o diminuare a suprafeţei spaţiilor verzi şi fragmentarea acestora, reclamând acţiuni din partea managerilor urbani şi a autorităţilor administraţiei publice.

Cuvinte cheie: planificare urbană, planificare spaţială, infrastructură verde, servicii ecosistemice, dezvoltare urbană durabilă, ecologie urbană.

INTRODUCTION

The relatively new science of "urban ecology" emerged from the research of the Chicago school (WU, 2014), and has significantly contributed to understanding the "urban ecosystems" – particular systems where the human species is a "*key species, controlling the structure and functions of the ecosystem*" (WALBRIDGE, 1997) – as socio-ecological complexes, where the urban nature forms a green infrastructure providing ecosystem services to the city dwellers (PETRIŞOR et al., 2016a; b), passing through three stages: (1) ecology *in* the city, (2) ecology *of* the city, and (3) urban sustainability (WU, 2014).

In more details, the urban nature belongs to four categories: (1) remains of the natural systems, (2) extensions of natural systems, (3) landscaped or managed areas, and (4) invasive or ruderal species (QURESHI & BREUSTE, 2010; BREUSTE et al., 2013), while the urban green infrastructure consists of: (1) ecological corridors, (2) urban areas, (3) industrial parks, (4) suburban areas, (5) sustainable drain systems, and (6) coastal areas (BENEDICT & MCMAHON, 2002; GILL et al., 2007; TZOULAS et al., 2007). Ecosystem services are the benefits offered by ecosystems to the human society and can be classified as (1) supply, (2) regulation, (3) cultural, and (4) support services (ZAKRI & WATSON, 2003; WATSON & ZAKRI, 2005).

This theoretical framework mentions green spaces as part of the urban nature and green infrastructure; they play an important role through the provided ecosystem services, contributing to increasing the health and welfare of city dwellers (TZOULAS et al., 2007; HEGETSCHWEILER et al., 2017), and to the urban sustainability and resilience (GILL et al., 2007; PETRIŞOR et al., 2016a), and are the "home" of urban biodiversity (PETRIŞOR, 2013). However, the ability of green infrastructure to provide ecosystem services depends on its continuity and connectivity. Fragmentation, which is correlated to sprawl (RAZIN & ROSENTRAUB, 2000), affects the structure and functions of green areas (LUCK & WU, 2002; PETRIŞOR et al., 2016), including their ability to provide ecosystem services.

However, the environmental issues associated with the lack of environmental awareness are a consequence of poverty or at least connected to it (TALLIS et al., 2008), particularly in developing countries (IANOŞ et al., 2009; PETRIŞOR et al., 2016b), or when natural resources are not seen as solutions for reducing poverty through their sustainable use (SAYER et al., 2012). This is the case of green spaces, which are often not considered based on all their benefits, but only based on the provided services, and are especially assessed simply as a vegetated surface (PETRIŞOR, 2015). Provided that the General Planning Guidelines (a 1996 law) requires planners to provide for each type of urban functional area a certain share of green spaces, developers found ways to withdraw from this requirement, by simply distorting the calculations. Initially, water bodies within the green spaces were included in the calculations instead of being subtracted; later, private green spaces were included together with the public ones. The most recent approaches based on satellite imagery included all vegetated areas (VLAD, 2013). A recent study has found out that the green infrastructure represents about 1/3 of the total area of Bucharest, corresponding to an average of 50 m^2/person, while the green spaces only account for 6.5 m^2/person, which is far below the European average (26 m^2/person) (PETRIŞOR, 2015); this result is also valid for other Romanian cities.

The research question addressed by this study relates to the actual dynamic of green spaces in Romania. The process described above is a simple data shift, but the use of such tricks permitted interventions resulting into the loss of green spaces, some of them brought to the public attention by the media. However, abandoned construction sites were invaded by spontaneous, invasive or opportunistic vegetal species, resulting into the emergence of systems that could be

labeled, from a remote sensing perspective, as "urban green spaces", since they lie within the city limits. From the ecosystem services viewpoint, each vegetated area is a potential provider of ecosystem services. Therefore, based on all these considerations, the present study aims to draw a balance and check whether, in the long run, green spaces were lost or gained in Romania.

DATA AND METHODS

The study used two datasets dealing with land cover and use, freely available from European and international sources, presented in Table 1. The data processing consisted of re-projecting and sub-sampling subsets for Romania, clipping the polygons affected by land cover and use changes by the natural protected areas, and ultimately computing areas using the X-Tools extension of ArcView GIS 3.X. The two data sets used (CORINE and Urban Atlas) differ in terms of temporal and spatial resolution – 1990-2012, entire territory, and a minimum mapping unit of 25 hectares and minimum width of linear elements of 100 meters for CORINE, and 2006-2012, only cities over 100,000 people, and linear elements with a width of 10 m and a minimum mapping unit of 0.25 ha for urban areas and 0.55 ha for non-urban areas (HAGENAUER & HELBICH, 2012). Due to this, the Urban Atlas data are recommended for urban studies, although the temporal resolution is not sufficient, while CORINE data are unable to catch changes not covering a large area (PETRIŞOR, 2015; PETRIŞOR & PETRIŞOR, 2015); we have to stress out that at the level of the European Union the Urban Atlas data are the only data set enabling local scale urban analyses, despite their limitations. Other issues characteristic to CORINE data include misclassification of satellite data and different classification schemes and resolutions from one period to another (JANSEN, 2007; PELOROSSO et al., 2011; VERBURG et al., 2011). At the same time, Urban Atlas data covered 14 cities in 2006 and 35 in 2012; only the common ones were used in this study for comparisons: Alba Iulia, Arad, Bacău, Brăila, Bucharest, Călăraşi, Cluj-Napoca, Craiova, Giurgiu, Oradea, Piatra Neamţ, Sibiu, Târgu Mureş, and Timişoara. The reason for using the two data sets is that CORINE data cover a broader period, but Urban Atlas data can validate the results at a finer spatial scale.

Table 1. Specifications on the data used in the study: dataset, provider, URL, remarks and transformations.

Dataset	Provider	URL	Transformation
CORINE land cover and use changes data (2012 – land cover and use; 2006-2012 – land cover and use changes)	Copernicus Land Monitoring Services	http://land.copernicus.eu/pan-european/corine-land-cover/lcc-2006-2012/view	Project into Stereo 1970, sub-sample for Romania
CORINE land cover and use changes data (2000 and 2006 – land cover and use; 1990-2000 and 2000-2006 – land cover and use changes)	European Environment Agency	http://www.eea.europa.eu/data-and-maps/	Project into Stereo 1970, sub-sample for Romania
Urban Atlas land cover and use changes data (2006, 2012 – land cover and use; 2006-2012 – land cover and use changes)	European Environment Agency	http://www.eea.europa.eu/data-and-maps/data/urban-atlas	Project into Stereo 1970, sub-sample for Romania

RESULTS AND DISCUSSION

The analysis aimed to look at the changes of urban green spaces during 1990-2012. The findings consist of looking at the total area covered by the green spaces based on land cover and use data (Fig. 1) and at its dynamicss based on land cover and use data.

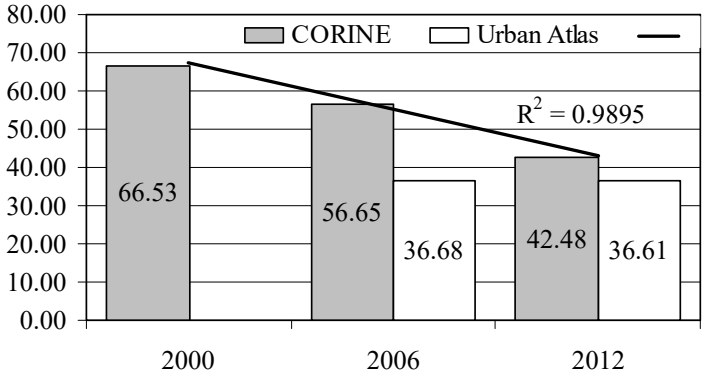

Figure 1. Total area covered by the green spaces in Romania based on CORINE and Urban Atlas data (values in km^2).

Figure 1 shows that, regardless of the data used, the total area of green spaces tends to decrease ($R^2 = 0.99$). The difference between the two data sets is explained by the fact that the Urban Atlas data cover only 14 of the over 3000 administrative units of Romania. However, this argument shows that CORINE data tend to underestimate the total area covered by green spaces, since the 14 units seem to include more than half of the total area estimated by CORINE.

This is an important argument sustaining that the Romanian urban green spaces are extremely fragmented (PETRIŞOR et al., 2016a), such that their area is less than the resolution of CORINE. A direct consequence of fragmentation is that small green spaces are functionally affected, including the ability to provide ecosystem services.

The analysis of the dynamics of land cover and use data provided inconclusive results. CORINE data showed no changes related to the green spaces for any of the periods (1990-2000, 2000-2006, and 2006-2012), while the Urban Atlas data indicate a loss of 0.57 km^2 and a gain of 0.49 km^2, consistent with the small difference between the Urban Atlas data for the total area of green spaces.

The main limitation of the present study is that it uses an "ecological approach", in the epidemiological sense of the term (MORGENSTERN, 1995), meaning that it is carried out at the level of the national territory, with all green spaces analyzed as a whole, instead of looking at the individual ones, for example the green spaces of a given city. Future research can attempt to correlate data obtained at the micro-scale with the overall results, and derive fine-tuned recommendations.

CONCLUSION

In summary, the study aimed to assess the dynamics of urban green spaces in Romania during 1990-2012 using geospatial data. The results indicate a clear decreasing trend, but also suggest that, besides being diminished, the Romanian green spaces are subject to significant fragmentation, able to reduce their functions and ability to provide ecosystem services to the city dwellers. The situation reclaims immediate action from the city managers and local administrations. Our findings provide additional evidence for the fact that political decision makers should make more use of scientific results in general, and ensure that the concerns related to the urban green spaces are addressed by the urban plans in particular. Planners should also be more aware of the fact that the green spaces are not only a legal requirement, but provide ecosystem services and contribute to the welfare of urban citizens and to a sustainable development of the administrative unit, with benefits for their plans.

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