Dynamics of Green Infrastructure Changes and Urban Growth in Hungarian Functional Urban Areas After the Regime Change

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Abstract

The green infrastructure (GI) within urban environment is a core issue in the sustainable development discourse of international literature and organisations. Several strategies and guidelines (such as Convention on Biological Diversity, The European Green Deal, EU biodiversity strategy for 2030) help to preserve and improve the natural environment and to implement effective measures for degraded ecosystems. The importance of GI is highlighted in urban and urbanised environment, because the negative effects of human activities often accumulate there, such as air pollution, soil degradation, water management, etc. As the European population is concentrated into cities and towns, one of the most effective ways to ensure a good quality of life is to develop urban green infrastructure (UGI).

The study gives an overview about the change of green infrastructure and new artificial land uses in Hungarian functional urban areas. Based on the Corine Land Cover Inventory (CLC), Land Use Changes (CLC CHA) database (1990 – 2018) and Urban Atlas (2012 – 2018) this paper fills this gap by analysing 19 towns and cities affected by the emerging artificial surfaces with the help of landscape metrics. The results show the importance of structural changes and regional differences and identify the change of quality of green infrastructure: The growth of urban living areas between 1990–2006, the dominance of motorway constructions and the marginal role of new urban green areas in the urban sprawl, as well as decreasing ratio of pastures and agricultural areas are identified. The study also describes some strengths and concerns about current spatial policy in Hungary, in order to support the planners, policy makers in strategic planning.

Introduction

The green environment within urban environment is a core issue in the sustainable development discourse of international literature and organisations. Several strategies and guidelines (such as UN 2001, EC 2019, 2021) help to preserve and improve the natural environment, as well as green infrastructure (GI) and to implement effective restoration measures for degraded ecosystems. The importance of GI is highlighted in urban and urbanised environment (Tulisi 2017, Moseley and Watts 2015), because the negative effects of human activities often accumulate there, such as air pollution, soil degradation, water management, etc. Furthermore, the change of ecosystem often goes in hand the change of urban areas. As the European population is concentrated into cities and towns, one of the most effective ways to ensure a good quality of life is to develop urban green infrastructure (UGI) (EC 2022). The paper aims to follow the tendency of changes of the two processes: change of green and urban environments in the scale of urban regions, called

Functional Urban Areas (FUAs) (OECD 2013) with the help of land cover databases, like Corine Land Cover and Urban Atlas. The research is formulated around the following methodological and ecological questions, with a particular focus on spatial planning of GI:

- How can green infrastructure (GI) and urban areas be defined with the use of Corine Land Cover nomenclature?
- What kind of changes are detected between 1990 and 2018 regarding GI and urban areas?
- How can be the changes described and explained through the land cover data?

Background and Literature Review

Various approaches are seen in the international literature to monitor and evaluate the elements of natural and semi-natural areas (e.g. Korkou et al. 2023, Van Oijstaeijen et al. 2020, Monteiro et al. 2020, Wang and Banzhaf 2018, Sandström 2002). The most common interpretation of UGI includes the micro- scale elements, such as green roofs, permeable green surfaces, green paths and streets, ponds, parks, and wetlands (Gill et al., 2007). However, for professionals, the system-based approach is more important to be able to handle processes through GI development. Moreover, there is also a broader scale that addresses the interactions between the different factors or aspects of GI system. However, all spatial scales exist in parallel, the regional scale often lags behind. Europe-wide, national and local monitoring systems are in place, but regional ones are often designed according to a single goal or institutional competence. In this context, this article serves as an example for describing GI according to related urban regions. However, this delineation cannot follow ecological units systemically or be classified into units under a single executive institution, such as a municipality or a nature conservation agency, but it can illustrate the GI around a core town.

Several studies apply land cover databases to delineate GI, however the official definition of green infrastructure (McMahon 2006) means a comprehensive green space system, analyzed from multiple perspectives. This study aims to give an overview of changes in regional scale, that is why applies given land cover database to define green infrastructure and urban areas. The delineation in this case is based on the nomenclature of databases. The Corine nomenclature (Bossard et al. 2000, Heymann et al. 1994) lists different land cover categories, with the following main surfaces: 1) Artificial surfaces, 2) Agricultural areas, 3) Forests and semi-natural areas, 4) Wetlands, 5) Water bodies. Most studies focusing on the porosity of surfaces consider categories 2–5) as open space. They often include category 141 (Green urban areas) in open spaces (Skokanová et al., 2020, Ronchi et al. 2018, Larondelle et al. 2014, Madureira and Andresen 2014, Huang et al. 2007, Schwarz 2010), as the urban environment plays a key role in the examination of open spaces and water permeability. From the perspective of ecosystem services, the naturalness of arable lands (211) is often questioned, acknowledging their food-producing services as supplying ecosystems (Máté 2024). According to Máté (2024), in the case of arable fields, this dilemma would be resolved if – as multifunctional areas – they also performed ecological functions, thereby helping the connectivity of habitats and ecosystem services (supply services) at the same time. Most of the arable land in Hungary plays a minimal role in ecological connectivity, however, it has contributed to increased diversity. Considering the different aspects this study follows the nomenclature of CLC and define urban areas as artificial surfaces (1. Artificial surfaces) and GI as open space (or GI from this perspective) as all the other (2. Agricultural areas, 3. Forests and semi-natural areas, 4. Wetlands, 5. Water bodies).

Method and Data

The study analyses all 19 Functional Urban Areas (FUAs) of Hungary based on geospatial information of Urban Atlas, delineated by OECD (2013) according to population data (Figure 1, Table 1). Also delineates the Morphological Urban Area (MUA) "as a territorially contiguous settlement area that can be distinguished from low-density peripheral and rural hinterlands" by Taubenböck et al. (2019) in order to detect the spatial distribution of urban growth: whether it is linked to the urban core or depict a scattered pattern within the FUA. The Urban Atlas provides data for all Hungarian FUAs for the years of 2012 and 2018. The study deals with changes between 1990 and 2018, for this time frame Corine Land Cover is suitable, however for the characteristics of urban areas in 2018 Urban Atlas offers a more punctual source. The study works with Corine Land Cover spatial data and add information from Urban Atlas as well.

Table 1: Population and area of functional urban areas. (Source: Urban Atlas)

FUA	Population 2018	Area (ha)	**FUA**	Population 2018	Area (ha)
Budapest	2 977 647	639 316	**Pécs**	247 794	185 765
Békéscsaba	112 424	106 083	**Sopron**	100 689	80 654
Debrecen	326 570	201 723	**Szeged**	241 791	160 906
Dunaújváros	85 124	61 632	**Szolnok**	159 343	144 064
Eger	99 994	100 634	**Szombathely**	147 879	134 327
Győr	251 239	204 720	**Székesfehérvár**	270 803	301 226
Kaposvár	109 038	145 678	**Tatabánya**	137 360	69 719
Kecskemét	187 235	182 029	**Veszprém**	133 593	131 317
Miskolc	287 348	164 577	**Zalaegerszeg**	108 569	139 881
Nyíregyháza	235 619	168 266	**Total**	6 220 059	3 322 516

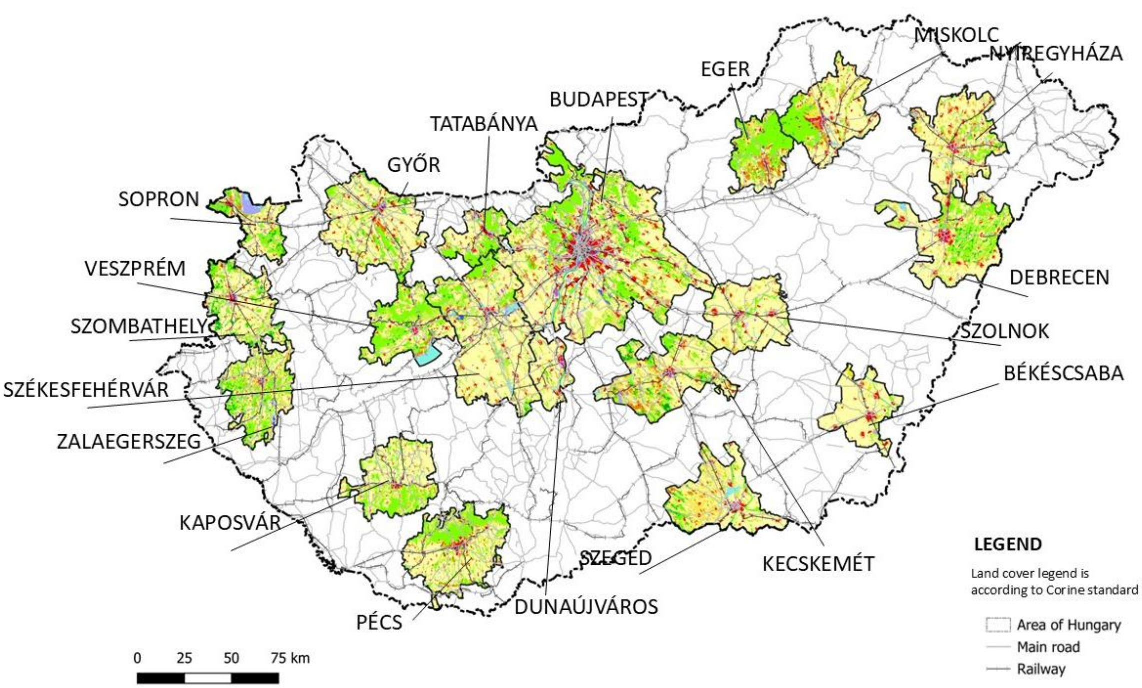

Figure 1: Functional Urban Areas in Hungary (Source: Urban Atlas, Corine Land Cover 1990)

Results

The results show the increase of urban areas and decrease of green infrastructure between 1990 and 2018 in all FUAs in Hungary. The area of the MUA increased in all FUAs together with +17%, particularly high growth detected in Nyíregyháza (+85%), Eger (+52%), Győr (+48%) and Kecskemét (+48%) FUAs. The growth is moderate in Tatabánya (+3%), Zalaegerszeg (+5%) and surprisingly in Budapest (+6%) FUAs. The case of Budapest is interpreted with the suburbanisation: the metrics of urban areas shows the change outside the core town, within the FUA region. In the case of Budapest, the growth is detected outside the capital core area (MUA), where 18% of growth is detected, that means more than 9600 hectares growth. The same tendencies (urban growth dominates in FUA region) are experienced in Debrecen, Dunaújváros, Szolnok and Zalaegerszeg FUAs. In these regions, not only the emergence of industrial and residential areas, but also the construction of motorways have contributed to growth – for example in Dunaújváros. The results show 3 type of growth pattern of Hungarian FUAs, regardi ng the spatial delineation:

1) Significant growth of MUA: Eger, Győr, Kecskemét, Miskolc, Nyíregyháza, Székesfehérvár FUAs

2) Significant growth of urban areas in FUA region (outside MUA): Budapest, Debrecen, Dunaújváros, Szolnok, Zalaegerszeg FUAs

3) Balanced growth in FUA region and in MUA: Békéscsaba (around 15%), Kaposvár (around 10%), Pécs (around 13%), Sopron (around 25%), Szeged (around 15%), Szombathely (around 30%), Tatabánya (around 5%) FUAs

The decrease of open space (GI) is significant in the greatest FUA, Budapest with 18733 hectares, and no of FUAs comes close to this magnitude. The decrease is relative high in Nyíregyháza, Debrecen, Székesfehérvár and Győr (with 4035-2341 hectares) FUAs and low in Eger, Kaposvár, Békéscsaba and Tatabánya FUAs (less than 700 hectares).

Table 2: The area in hectares of Morphological Urban Area (MUA), urban areas and green infrastructure in different FUAs in 1990 and 2018 (Source: Corine Land Cover)

FUA	MUA area 1990	MUA area 2018	Increase of MUA	Urban areas 1990	Urban areas 2018	Increase of urban area	Area of GI 1990	Area of GI 2018	Decrease of GI
Budapest	42035	45761	3726	53307	62916	9609	98757	98073	-684
Békéscsaba	1979	2246	267	4143	4800	656	532885	514153	-18733
Debrecen	5143	6351	1208	7762	10533	2771	186914	183053	-3860
Dunaújváros	1638	1833	195	3588	4807	1219	55017	53719	-1298
Eger	1188	1802	614	4293	4378	85	94859	94160	-699
Győr	2555	3812	1258	12162	13201	1039	187140	184800	-2341
Kaposvár	1713	1880	167	5204	5602	398	172909	171667	-1242
Kecskemét	2537	3633	1096	5312	5684	372	137590	136895	-695
Miskolc	3689	4750	1061	10080	10636	556	149654	147978	-1676

Nyíregyháza	2575	4760	2185	9253	11105	1852	154752	150717	-4035
Pécs	2978	3407	429	7011	7786	775	174379	173008	-1372
Sopron	1156	1486	330	2969	3606	637	75073	74035	-1038
Szeged	4544	5117	573	5359	6270	911	147055	145662	-1393
Szolnok	2788	3196	409	6187	7457	1270	278396	275450	-2946
Szombathely	1746	2419	672	5132	6435	1303	127098	125082	-2016
Székesfehérvár	3048	3873	825	14572	16423	1850	132707	130887	-1820
Tatabánya	2181	2306	125	4789	4892	103	62097	61591	-507
Veszprém	1359	1629	271	6165	6948	783	116018	115043	-975
Zalaegerszeg	1340	1401	61	5410	6478	1069	131534	130409	-1125

Discussion and Conclusion

The increase of urban areas and morphological urban areas are quite natural process in Central Eastern European countries, but in Europe as well after 1990 (Feranec et al. 2017), however the regime change (1989) in the Eastern part of Europe played crucial role in this process. The 1990s-2000s period in the region was one of economic restructuring, leading to land-intensive growth; this land-intensive growth continued until 2006, which led to more intense suburbanisation (Haase et al. 2018). Based on the CLC data, the study showed that land cover has been significantly affected: in cities where significant growth has been observed, growth of industrial and urban living areas dominates, but motorway construction are important background of growth of artificial areas as well.

The study also proves the outstanding role of Budapest FUA, as it is the home to one third of the country's population and has three times the area of the second largest FUA. For historical reasons, Budapest is the economic and intellectual centre of the country and in this respect no other region can compete with it. The extent of changes and the significance role of the capital requires single analyses.

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