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Measuring socio-economic disparities in green space availability in post-socialist cities

György Csomós [a], Zsolt Jenő Farkas [b], Ronald A. Kolcsár [c], Péter Szilassi [c], Zoltán Kovács [d,*]

[a] University of Debrecen, Department of Civil Engineering, 2-4 Ótemető út, Debrecen, 4028, Hungary
[b] Centre for Economic and Regional Studies, Great Plain Research Institute, 3 Rákóczi út, Kecskemét, 6000, Hungary
[c] University of Szeged, Department of Physical Geography and Geoinformatics, 2-6 Egyetem utca, Szeged, 6722, Hungary
[d] Research Centre for Astronomy and Earth Sciences, Geographical Institute, 45 Budaörsi út, Budapest, 1112, Hungary

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ABSTRACT

Since the collapse of communism, countries in Central and Eastern Europe have experienced significant socio-economic changes that have affected the urban landscape and the spatial organization of cities. These processes have also generated significant changes in the availability of urban green spaces for local residents, resulting in new forms of inequalities. In the light of recent debate on socio-spatial segregation, the concept of environmental justice has gained increasing attention. Using three Hungarian post-socialist cities as case studies, this paper explores the relationship between different types of residential areas in terms of the age, education, and income level of people, and the availability of urban green spaces. To do this, we introduce a demand-supply composite index that contains featured indicators of urban green space availability. The results show that in terms of UGS availability, major disparities exist both among different socio-economic groups and different types of neighbourhoods in the investigated cities. Although legacies of the past are still important, the emerging disparities of green space availability can be linked to new forms of segregation including highly segregated neighbourhoods of urban poor and the new upmarket housing developments of the affluent. Our results also suggest that regardless of local governments' recebt efforts to provide residents with equal access to urban green spaces, environmental justice remains a concern for urban planning in post-socialist cities.

1. Introduction

During the past three decades, due to suburbanization and urban sprawl (Hirt, 2007; Leetmaa & Tammaru, 2007; Ouředníček, 2007, Hardi, Repaská, Veselovský, & Vilinová, 2020) cities in Central and Eastern Europe (CEE) have experienced a continuous population decrease (Mykhnenko & Turok, 2008). Besides population shrinkage the socio-economic polarization of local society (Daskalova & Slaev, 2015; Marcińczak, Musterd, & Stę;pniak, 2012), the restructuring of local economy (Gros & Steinherr, 2004), the transformation and reconfiguration of urban space (Kotus, 2006; Sailer-Fliege, 1999; Taubenböck, Gerten, Rusche, Siedentop, & Wurm, 2019) also gained momentum. These cities have also been subject to the various effects of globalization and neoliberal urbanism. During communism, the spatial development of cities in CEE was under the strict control of the state, which prioritizedthe construction of high-rise housing estates providing homes for masses of workers arriving in cities. In the transition period, the planning power of the state decreased, the development of cities was affected by a sort of neoliberal course (Marcińczak, Musterd, & Stę;pniak, 2012), favouring the interests of private (often global) investors who had the money and resources to implement developments in cities, even if this process generated conflicts with the local residents. The most visible imprints of this process have been, on the one hand, the spread of new residential neighbourhoods in the form of gated communities and other upmarket compounds (Balčaitė & Krupickaitė, 2018; Blinnikov, Shanin, Sobolev, & Volkova, 2006; Kovács & Hegedüs, 2014) providing homes for the better off, and on the other hand, the commercial and residential gentrification of inner-city neighbourhoods to host business activities and affluent (often foreign) residents (Kubeš & Kovács, 2020). Due to recent developments, socio-spatial segregation and urban inequalities at the micro-scale have strengthened (Kovács, 2020) even though some studies reported a decreasing trend in the level of segregation (see, for

* Corresponding author. University of Szeged, Department of Economic and Social Geography, 2 Egyetem utca, Szeged, 6722, Hungary.
E-mail addresses: csomos@eng.unideb.hu (G. Csomós), farkas.jenozsolt@krtk.hu (Z.J. Farkas), kolcsar@geo.u-szeged.hu (R.A. Kolcsár), toto@geo.u-szeged.hu (P. Szilassi), zkovacs@iif.hu, zkovacs@geo.u-szeged.hu (Z. Kovács).

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example, Daskalova & Slaev, 2015; Marcińczak, Gentile, & Stę;pniak, 2013; Rufat & Marcińczak, 2020; Sýkora, 2009, pp. 387–395).

The post-socialist transition and globalization have not only affected the spatial reconfiguration of urban space and the transformation of the local society but have also generated shifts in lifestyle and preferences of residents towards housing and urban green spaces (Badiu, Onose, Niță, & Lafortezza, 2019; Marcińczak, Musterd, & Stę;pniak, 2012; Kronenberg, Pietrzyk-Kaszyńska, Zbieg, & Żak, 2016; Silva, Viegas, Panagopoulos, & Bell, 2018; Zuzańska-Żyśko & Dyszy, 2021). This issue seems to be especially challenging now, since during communism cities were affected by mass housing construction and immigration, generating a large-scale expansion of their built-up area, while the development of urban green spaces was by and large neglected (Sailer-Fliege, 1999). The state-controlled urban planning system paid little attention to satisfying the needs of people in the newly developed neighbourhoods of cities. Of course, the pre-socialist urban cores contained some smaller green spaces (typically public gardens), but their ecosystem services were restricted to a limited number and types of cultural services. After the collapse of communism private real estate developers created exclusive private and semi-private urban green spaces (UGS) for residents living in gated communities and other upper-middle class housing. As Spórna and Krzysztofik (2020) noted these newly built residential estates offer interesting cases of reurbanisation with their 'urban village' type physiognomy.At the same time, local municipalities could only afford the revitalization of some deprived UGS, which were typically the largest or most frequented ones. As a consequence of post-socialist transformation, UGS have become available increasingly unevenly for different segments of local society (Csomós, Farkas, & Kovács, 2020).

In the growing body of literature on post-socialist urban transformation, the concept of environmental justice has recently gained increasing attention (Badiu et al., 2019; Jian, Luo, & Chan, 2020; Kabisch, Strohbach, Haase, & Kronenberg, 2016; Kolcsár & Szilassi, 2018; Kronenberg et al., 2020; Łaszkiewicz, Kronenberg, & Marcińczak, 2018; Matthew McConnachie & Shackleton, 2010; Nagy, Vida, Boros, & Ćirić, 2019). At the international level, both in the European Union and the United States, recommendations have been addressed to local governments to provide citizens with UGS being accessible within 10 min walking time (EC−UN-Habitat, 2016; Poelman, 2016). Further, the importance of UGS as being an efficient tool for reducing air pollution (Molnár, Simon, Tóthmérész, Ninsawat, & Szabó, 2020) and mitigating climate change effects (Gál, Skarbit, Molnár, & Unger, 2021) has been widely recognized not only by professionals but also by decision-makers (Bush, 2020; Kabisch & van den Bosch, 2017, pp. 207–220; Pauleit et al., 2019). Local governments of post-socialist CEE cities have also started to make efforts to organize the urban space more harmoniously and provide equal opportunities for their residents. The current urban planning documents used in CEE countries must contain anti-segregation plans to help cities eliminate or at least reduce segregation. The provision of UGS being equally available for residents is in line with anti-segregation efforts and inspire local governments to accomplish environmental justice goals.

In this paper, we examine the availability of UGS among inhabitants belonging to different sociodemographic groups and residing in different neighbourhoods in three Hungarian cities: Debrecen, Kecskemét, and Szeged. Each city has a population of over 100 thousand, and all of them serve as regional centres for the economy, public administration and culture (including higher education) in the urban hierarchy. Further, they are considered to be growth poles in their wider regions. The main objective of this research is to measure the level of environmental inequalities in these cities while exploring how different types of population groups and residential areas are supplied by green spaces. For the analysis, we use a novel demand-supply composite index (DSCI) that considers various indicators. Applying the methodology we aim to contribute to a deeper understanding of environmental justice issues in post-socialist cities and provide information to urban planners about the necessity of future interventions regarding the development of UGS. The rest of the paper is organized as follows: In Section 2, we provide a brief overview of the evolution of post-socialist cities in the context of the location of UGS. In Section 3, we present the data and methods we applied during the analysis. Section 4 presents the analysis and the main research findings. In Section 5, we discuss the results and draw our conclusions.

2. The socio-spatial evolution of cities in Central and Eastern Europe

The majority of cities located in the CEE have followed a uniform socio-spatial model, at least since the mid-twentieth century, when the political landscape of countries in the region shifted towards state socialism. Pre-socialist, socialist and post-socialist models of urban development have distinctly affected urban structure and the spatial allocation of UGS. To understand these processes, we need to consider the socio-spatial evolution of CEE cities in the historical context.

Before being affected by communist ideology, cities in CEE had been characterized by a socio-spatial pattern resembling that of Western European cities (Szelényi, 1983; Enyedi, 1998, pp. 9–34). These cities grew organically without any major urban planning interventions for a long time. Due to the fact that during the pre-socialist era trade and manufacturing of agricultural products dominated most of these cities while heavy industry remained a secondary segment of the local economy, these cities experienced moderate growth in terms of their population and area as compared to cities in core areas of Western Europe. Before World War II, only a few small UGS (e.g., public gardens) with less diverse ecosystem services were developed in these cities adjoining some large urban parks that were carved out of surrounding natural areas in the early 20th century.

From the late 1940s, as a consequence of the shift towards communism, radical changes occurred in the socio-economic system of CEE countries, significantly affecting the urban planning realm, the spatial configuration of cities and the spatial allocation of UGS. First, as an outcome of the centralization of political power, urban planning became subject to the strict control of the state. The former organic urban growth model was replaced by a highly centralised, overregulated and politically motivated planning system, where egalitarianism was the main goal. Second, in line with the Soviet-type economic planning ideology, a large-scale state-driven industrialization process swept across the region, transforming the existing towns into loci of industrial production (Frank, 1994; Vonyó & Klein, 2017). During this process, factories and other manufacturing plants were established in cities that had not been home to significant industries previously. By offering a large number of jobs, these new industrial hubs started to act like magnets attracting labour from the countryside. To provide housing for the newly arrived industrial workers and their families, large housing estates were developed mostly on former agricultural land and natural areas at the fringe of the pre-socialist compact city (Benkő, 2015; Ouředníček & Kopecká, 2021; Sailer-Fliege, 1999). These areas became dominated by large dormitory estates with 4–10 storey pre-fab buildings that were embedded in urban green spaces (Csomós, Farkas, & Kovács, 2020). While most socialist housing estates were located at the edge of the pre-socialist city, some pre-fab buildings were also installed within the historical core on bombed out sites (i.e. war damage). In this case, the buildings were not surrounded by green spaces but extended the densely built core. In the first half of the socialist era, the main objective of urban planning was to find locations for industrial plants and housing estates within the city boundaries. At the end of the 1970s, when economic recession hit the communist countries, the momentum of industrialization and high-rise building construction started to ease, and the role of centralized urban planning started to diminish.

In addition, due to the shortage of housing, self-built and sometimes informal housing construction became dominant at the peripheries of cities from the early 1960s (Vasilevska, Milanovic, Nikolic, Vranic, & Milojkovic, 2015; Vranic, Vasilevska, & Haas, 2015), resulting in

excessive village-type outskirts for less affluent people. These outskirts hosted small-scale agricultural activities, and almost every property was equipped with a small private garden. Because these areas developed in a rather unplanned manner, they contained very few UGS.

After the collapse of communism in 1989–1990, the CEE countries witnessed a complete transformation that impacted all spheres of life, including the economy, the political structure, political ideology, the legal system and the stratification of society (Kornai, 2006). As Taubenböck et al. (2019) argued, 'the centralised and hierarchically organised planning system of the socialist era was abruptly replaced by a fragmented local self-government structure where economic stakeholders gained influence over land use decisions.' As a consequence, during the transition, cities evolved according to the neoliberal paradigm, and the main task of urban planning was to serve the interests of private investors. Since the mid-1990s, a new segment of the local society has emerged with people who have managed to take advantage of the economic changes brought about by the transition (e.g., privatization, restitution). For wealthy families, new neighbourhoods were developed containing gated communities and other upmarket housing (Balčaitė & Krupickaitė, 2018; Kovács & Hegedüs, 2014). Such neighbourhoods feature high-quality and well-maintained UGG that are supplied with high-quality amenities such as tennis courts, swimming-pools, and outdoor gyms. For the location of these affluent neighbourhoods, local governments often offered previously unused lands on the edge of the built-up areas of cities being separated from industrial activities and high-rise housing estates.

As a consequence of the polarization and fragmentation within local society, poor, unskilled and marginalized people started to concentrate in highly segregated neighbourhoods (see, for example, Großmann, Arndt, Haase, Rink, & Steinführer, 2015; Sýkora & Bouzarovski, 2012). These people are considered to be the most vulnerable segment of the urban population. Segregated areas often lack one or more types of utilities, paved roads, and UGS. Since the accession to the European Union in 2004/2007, the elimination of segregation has been high on the agenda in local urban planning strategies.

In conclusion, based on the pre-socialist, socialist, and post-socialist epochs of socio-spatial development, we can distinguish five major types of residential areas in post-socialist cities in CEE: 1) the inner-city area covering the historical core, 2) residential areas containing large housing estates built during communism, 3) the urban outskirts, 4) affluent neighbourhoods developed for wealthy families after 1990, 5) and highly segregated neighbourhoods inhabited by the urban poor. Obviously, these residential areas are not always entirely separated in the urban space, for example, the historical core might contain some socialist-type block of flats, while some parts of the urban outskirt might be transformed into affluent neighbourhoods or segregated lower-class areas. While acknowledging the effects of historical development and path-dependency on the availability of UGS in different types of residential areas, we assume, that due to some recent socio-economic developments (e.g., new mobility flows within the cities that influence the composition of residents in particular areas, the financial support of the EU that allows local governments to develop UGS, and the inclusion of anti-segregation programs in development strategies), the availability of UGS has changed. The DSCI is considered to be a useful tool to measure how path-dependency and the recently emerging socio-economic restructuring have affected the availability of UGS for different segments of local society living in distinct types of neighbourhoods.

3. Materials and methods

3.1. Data collection

To calculate the demand-supply composite index (DSCI) for the three cities we used three different datasets. First, we identified and selected UGS that were available for residents according to the Urban Atlas 2012 (provided by Copernicus Land Monitoring Service). Further, based on the opinions of local experts, we identified UGS that were for methodological reasons not recognized by the Urban Atlas. To delineate the compact city (i.e. the largest contiguous built-up area within a Functional Urban Area), we used the Urban Atlas as well. Second, the socio-economic data of the population provided by Geox Ltd. for 100 × 100 m grid vector databases were used for each city. The grid cells were the basic spatial units of the analysis: however, we also used additional indicators to create the DSCI. We used the Ecosystem Map of Hungary (Agrárminisztérium 2019)(issued by the Ministry of Agriculture) to calculate the total green surface area for each 100 × 100 m grid. Finally, the Urban Atlas, the ArcMagyarország (by Geox Limited), and the OpenStreetMap (by OSM Foundation) were applied to create the map of each city.

3.2. Composition of the DSCI

Studies focusing – within the context of environmental/spatial justice – on the accessibility of UGS and the ecosystem services they provide, usually consider demand and supply factors highly important (see, for example, Cortinovis & Geneletti, 2020; Dony, Delmelle, & Delmelle, 2015; Jian et al., 2020; Lee & Hong, 2013; Li et al., 2019; Liu, Remme, Hamel, Nong, & Ren, 2020; Ramyar, 2019; Wang et al., 2015Xing, Liu, Liu, Wei, & Mao, 2018). These studies inspired us in developing our demand and supply index. However, when conceptualizing the methodology, we had to take into account the special characteristics of post-socialist cities. The DSCI altogether integrates five demand and three supply indicators (Table 1).

We normalized the indicators with MIN-MAX normalization. This allowed us to combine indicators with different units of measurements and different scales. In the formula, v'_i is the normalized value of the indicator between the range of 0.0–1.0, v_i is the value of the indicator in a particular grid, and min_v and max_v are the minimum and maximum values of that indicator:

$$v'_i = \frac{v_i - min_v}{max_v - min_v} \quad (1)$$

In the case of the indicators "per capita income", "total area of green surfaces", and "distance of the nearest UGS" we used inverse normalization:

$$v'_i = \frac{max_v - v_i}{max_v - min_v} \quad (2)$$

The indexes were calculated as an unweighted sum of the indicators

Table 1
The description of demand and supply indexes constituting the DSCI.

	Indicator name	Data source
Demand index	Population in 100 m × 100 m grids	100 × 100 m database of Geox Ltd.
	Population under the age of 18 in 100 m × 100 m grids	100 × 100 m database of Geox Ltd.
	Population above the age of 63 in 100 m × 100 m grids	100 × 100 m database of Geox Ltd.
	Per capita income (HUF) in 100 m × 100 m grids	100 × 100 m database of Geox Ltd.
	Total area of green surfaces in 100 m × 100 m grids	Own calculation based on the Ecosystem Map of Hungary
	Indicator name	**Data source**
Supply index	Number of UGSs within 300 m/600 m/900 m[a] for 100 m × 100 m grids	Own calculation
	Distance of the nearest UGS in m for 100 m × 100 m grids	Own calculation
	Per capita area of UGS (sqm/person) 100 m × 100 m grids	Own calculation

[a] We apply buffer zones of various sizes based on the area of UGS (UGS under 4 ha: 300 m buffer zone; UGS between 4 and 10 ha: 600 m buffer zone; UGS above 10 ha: 900 m buffer zone).

(see, Table 1). Following this, by means of the ArcGIS Quantile classification function, the demand and supply indexes were independently classified into three categories: low supply/demand, average supply/demand, and high supply/demand. Then a composite index was made which resulted in nine classes. In the next step, we merged the nine classes into five main classes: 1) HSS - *high supply surplus* (i.e., low demand and high supply), 2) HDS - *high demand surplus* (i.e., high demand and low supply), 3) MSS - *moderate supply surplus* (i.e., average demand and high supply, and low demand and average supply), 4) MDD - *moderate demand surplus* (i.e., average demand and low supply, and high demand and average supply), and 5) BDS - *balanced demand and supply* (i.e., average demand and average supply, low demand and low supply, high demand and high supply).

In the analysis, we discovered relationships between particular DSCI categories and the residential area types characterizing post-socialist cities.

4. Results

As Table 2 shows, in each city, the highest number of grid cells and population belong to the BDS class, which means that for most residents the availability of UGS is balanced. The two extreme HDS and HSS classes contain the smallest number of grid cells and population. In addition, a smaller number of population and grid cells belong to the demand surplus classes (either HDS or MDS) than to their supply surplus counterparts.

Importantly, the age structure of the population located in the HSS class is the youngest in each of the investigated cities. That is, the HSS class hosts the largest proportion of children (i.e. 0-14 years old) and the smallest proportion of elderly people (i.e. aged 63 and older). In contrast, the BDS class can be characterized by the smallest proportion of children and the highest proportion of elderly.

There are distinct differences between the average income levels of people belonging to particular classes (the average income level of the total population per city is 100 percent). In the case of each city, the average income level of the HDS class is much below the level of the HSS class, but the magnitude of the differences varies from city to city. The smallest difference (4.57 percent) between the average income level of the two classes can be detected in Szeged. In the case of Kecskemét, the difference is 10.85 percent, and in the case of Debrecen, it is the greatest with 18.66 percent. In Szeged, people with the lowest average income level are concentrated in the BDS class. This pattern originates from two specific historical facts. First, Szeged is a planned city. In 1879, the River Tisza flooded almost the entire city and destroyed a significant part of the existing housing stock making 60,000 people homeless. Following the disaster, the city was rebuilt according to a ring-shaped layout replacing the previous organic morphological pattern. Second, during the first half of the 1990s, a series of wars of independence broke out in neighbouring Yugoslavia, and Szeged is located only 15 km from the border. Therefore, as opposed to other parts of Hungary foreign direct investments bypassed Szeged in the 1990s. As a consequence, wealth inequalities and socio-economic segregation are less acute in Szeged than in Kecskemét or Debrecen, and this phenomenon is reflected in the characteristics of DCSI classes as well.

Not surprisingly, the educational level of people located in the HSS class is also much higher than that of people located in any other classes, except in the case of Szeged, where the educational level of the HSS and HDS classes is almost equal.

In conclusion, the HSS class (i.e. areas with high availability of UGS) contains the wealthiest and the most educated section of local society, the HDS class (i.e. areas with low availability of UGS) generally hosts a less wealthy and less educated population, whereas people with average income and education levels are concentrated mainly in the BDS class (i.e. areas with balanced UGS availability). In addition, the proportion of children is high in both HDS and HSS classes, whereas the BDS class typically exhibits the highest proportion of old people.

As the next step, we juxtaposed DSCI classes with urban space to determine whether there is a relationship between different types of residential areas and particular DSCI classes. This analysis can be used to ascertain whether post-1990 urban planning interventions have helped mitigate the environmental inequalities produced under communism.

Figs. 1–3 show the geographical location of DSCI classes in each of the investigated cities by grid cells. In addition, the numbering of particular types of residential areas can be seen in map "B" in each Figure. Both Debrecen and Kecskemét can be characterized by the presence of a huge urban park at the edge of the city that were once natural areas. In contrast, Szeged does not have a similar urban park. The reason for this is the unique geographical location of Szeged; the Tisza River flows through the city and the largest green spaces are located alongside the river.

As in the case of many other cities around the world, the historical urban cores (indicated by 1 on map "B") are located in the central parts of the surveyed cities. These are densely built areas that contain historical buildings that were generally constructed well before the communist era. These CBD-like areas feature commercial, cultural, administrative, and residential functions (Sailer-Fliege, 1999). Because residential buildings located in these areas generally contain outdated apartments with high density providing inadequate opportunities for families to raise children, young families do not tend to choose the historical urban core as place of residence. For this reason, the

Table 2
Summary statistics of DSCI classes in the case of each city.

City	DSCI class code[a]	Number of grid cells	Population	Population aged 0–14 (% of the total population)	Population aged 63 and above (% of the total population)	Average income (% of the average income of the total population)	Share of people having higher education degree	Average distance between the centre of grid cells and the perimeter of the nearest UGS
Debrecen	HDS	198	8527	13.50	21.56	90.81	21.66	1208.30
	MDS	686	31,294	13.48	23.03	97.12	26.34	751.48
	BDS	1347	99,603	12.91	23.79	100.32	26.10	273.33
	MSS	624	19,390	14.84	21.77	104.04	30.78	261.60
	HSS	238	6171	15.59	19.36	109.47	36.74	111.41
Kecskemét	HDS	92	3595	18.14	18.58	93.42	10.85	901.54
	MDS	537	20,428	15.73	22.72	95.84	18.78	521.70
	BDS	933	47,114	14.20	23.18	101.43	23.84	233.39
	MSS	445	11,509	15.01	22.09	102.67	27.51	214.68
	HSS	144	2395	18.41	17.12	104.27	27.54	146.27
Szeged	HDS	163	8968	14.06	24.19	100.02	32.56	672.45
	MDS	624	38,950	13.23	23.03	100.08	29.43	440.79
	BDS	1046	70,714	12.39	23.82	99.04	26.17	211.85
	MSS	479	14,442	14.19	23.09	103.00	31.50	169.12
	HSS	,228	4684	15.01	21.33	104.59	32.59	102.30

[a] HDS: high demand surplus; MDS: moderate demand surplus; BDS: balanced demand and supply; MSS: moderate supply surplus; HSS: high supply surplus.

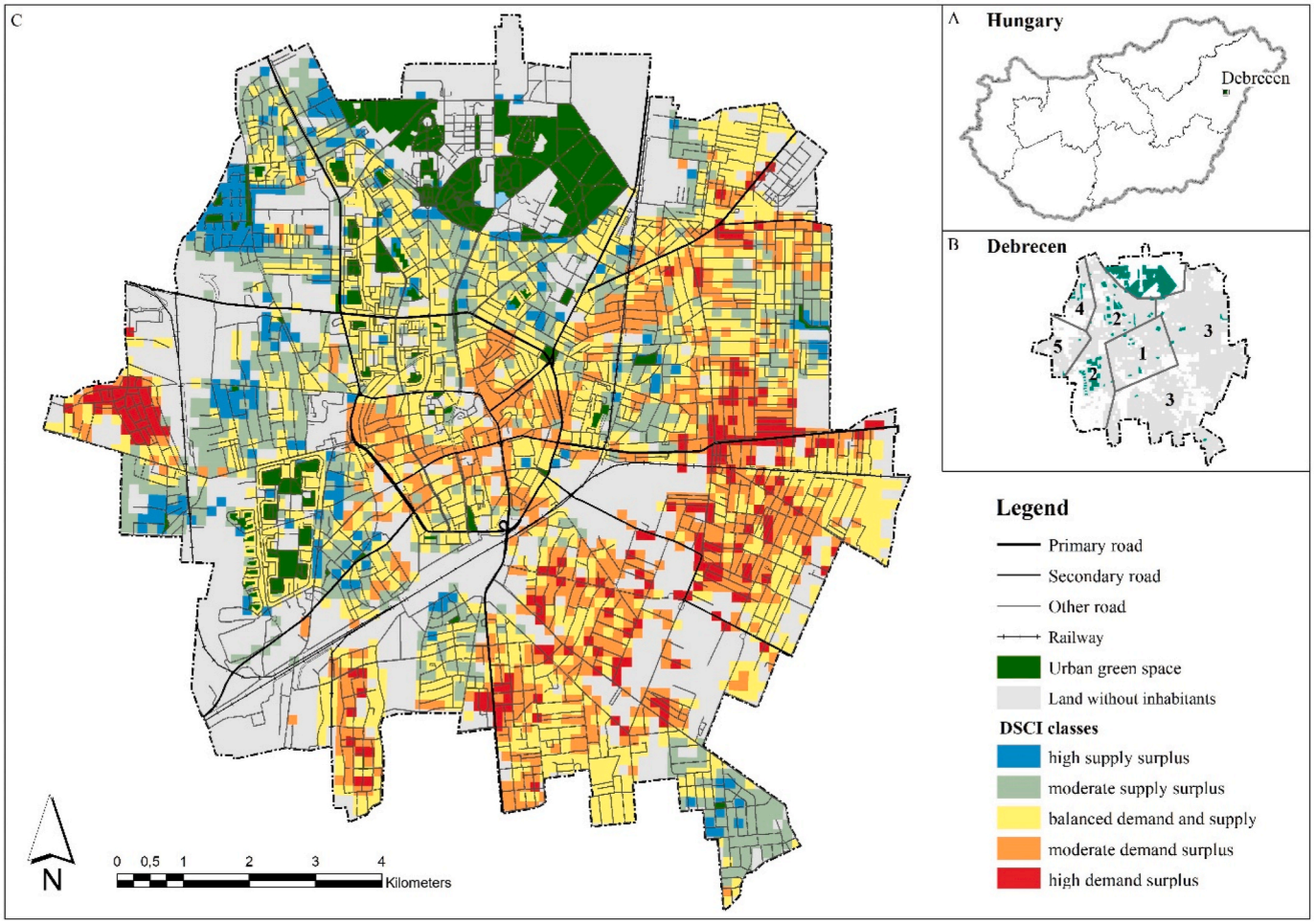

Fig. 1. The geographical visualization of DSCI classes and residential area types in Debrecen.

proportion of young people is low and conversely, the proportion of elderly is high in this area. However, due to the fact that the pre-socialist cities had contained some small-scale UGS and the local governments have incorporated some "pockets parks" with exclusive cultural services, the DSCI in the historical urban core is balanced or has a moderate demand surplus.

Alongside the pre-socialist city, large-scale housing estates (indicated by 2 on map "B") were built during the state-socialist era, while the development of inner-cities was neglected. Socialist housing estates host a large quantity of pre-fab buildings generally with 4–10 storeys (some of them are even higher) containing highly uniform medium-sized (ca. 50 sqm) dwellings. The apartments were originally allocated to middle class people and young families with children (Szelenyi, 1987), as opposed to Western Europe, where similar types of housing estates were designed for low-income residents, often immigrants (Kovács & Herfert, 2012) Musterd & van Kempen, 2007). In the surveyed cities, around one-third of the population live in such apartments. Although both the number of residents and the population density are high in this type of area, the DSCI is balanced. This can be explained by the fact, that during the 1970s, when most of the socialist-type housing estates were developed, large tracts of freely available natural lands were designated as sites of high-rise buildings offering large public open spaces (Protić, Mitković, & Vasilevska, 2020; Ouředníček & Kopecká, 2021). In subsequent decades these open spaces were gradually converted to green spaces with leisure and sports facilities.

During communism, centrally controlled urban planning primarily focused on choosing the most optimal locations for factories and housing estates. The development of the outskirts (indicated by 3 on map "B") was almost completely neglected and uncontrolled. These low status areas were generally separated from the central area by major infrastructure elements (e.g. railway lines, main roads), public institutions (e.g. schools and hospitals), and factories. The outskirts occupied large areas and contained modest socialist and pre-socialist detached single-family houses (Sailer-Fliege, 1999). During the transition, in some major post-socialist cities (e.g. Sofia, Vilnius, Budapest), these areas were often transformed into affluent neighbourhoods serving the needs of better-off families (Daskalova & Slaev, 2015; Kovács & Hegedüs, 2014 Krupickaitė, Pociūtė, & Peciukonytė, 2014). Due to this process, the socio-economic status of the outskirt's population is rather mixed. In the case of mid-sized post-socialist cities like Debrecen, Szeged, and Kecskemét, or Łódź in Poland (Szafrańska, Coudroy de Lille, & Kazimierczak, 2019), for instance, the transformation of the outskirt is not so evident. Because socialist urban planning neglected the development of the outskirts, they contain hardly any UGS. For this reason, besides some balanced areas, a significant part of the outskirts belongs to the MDS and HDS DSCI classes (see Figs. 1–3). This is also underpinned by the fact that in each of the surveyed cities, people located in MDS and HDS classes are at the greatest distance from the nearest UGS. In addition, the age structure of the outskirts' population is younger than that of the central area, and in the case of Hungary, it is expected that in the future it will become even younger. In 2016, the Hungarian government introduced the Family Housing Allowance Program, a new instrument to help stop the massive population decrease in Hungary. The program offers financial assistance for young families with at least three children to build new houses. This initiative enables less affluent families living in pre-fab housing to relocate into single-family homes in the outskirts

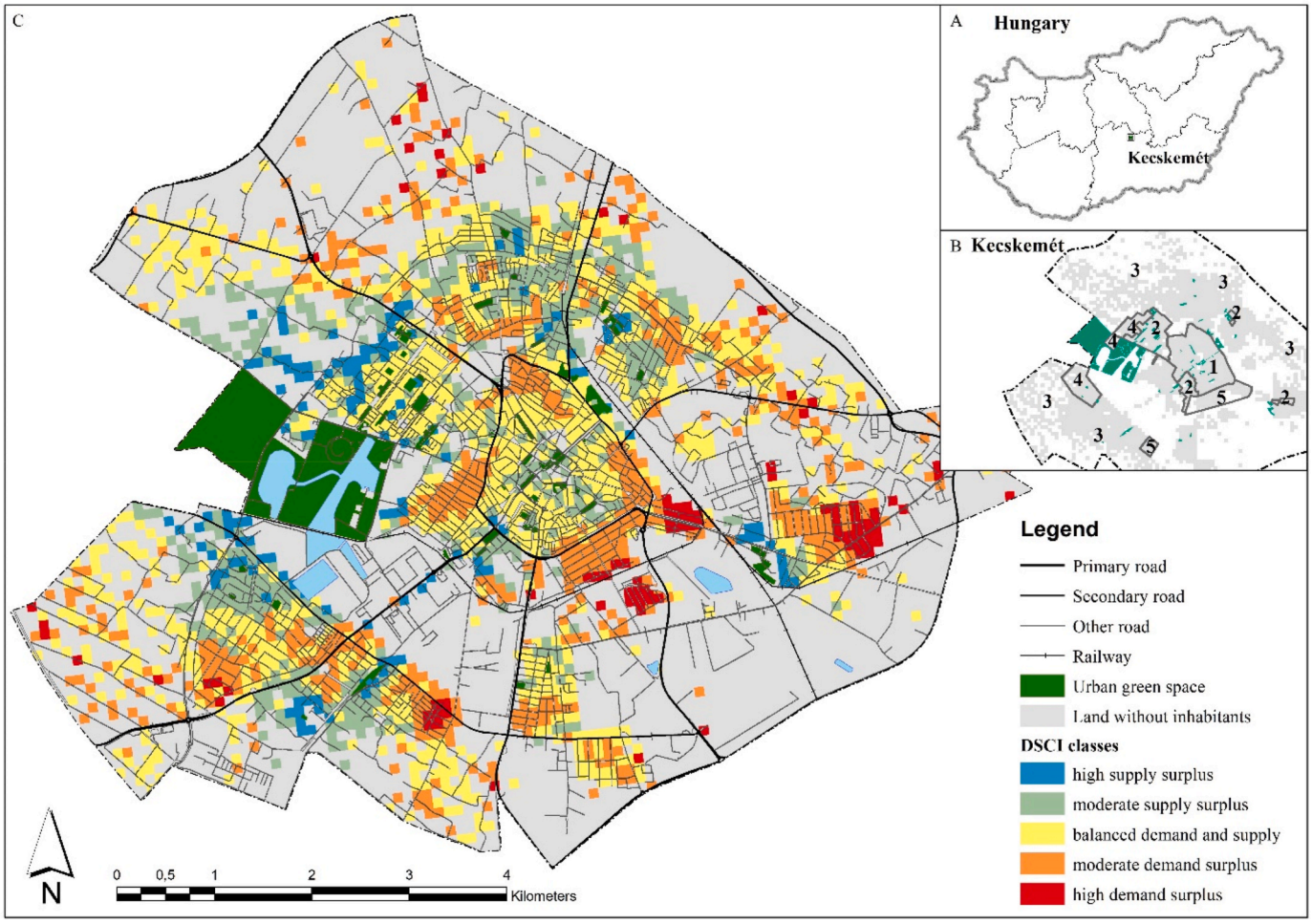

Fig. 2. The geographical visualization of DSCI classes and residential area types in Kecskemét.

where they can find affordable plots. In many Hungarian cities, a new pattern of inner-urban residential shift can be observed from the housing estates towards the outskirts. Therefore, it is expected that the need for UGS in the outskirts will become even greater even though these neighbourhoods lack open spaces.

During the transition, a new segment of local society has emerged, the so-called 'post-socialist elite', encompassing those who managed to take advantage of the privatization and had the opportunity to launch their own business. After 1990, the local political leadership favoured the interests of the post-socialist elite providing them the best possible locations in the city to establish affluent neighbourhoods (indicated by 4 on map "B"). These neighbourhoods comprise gated communities, up-market housing and the highest quality private and semi-private UGS in the city (Balčaitė & Krupickaitė, 2018; Kovács & Hegedüs, 2014). In addition, both the socio-economic status and the level of education of the population living in this type of residential area are high, and the age structure of the residents is the youngest in the city (see Table 2). Not surprisingly, almost all grid cells of affluent neighbourhoods belong to the HSS class, which means that the availability of UGS is very high.

The communist era could be characterized by relatively low socio-economic inequalities, a permanent housing shortage, a centrally driven housing policy that influenced the spatial distribution of the population, and restricted land markets (Szelényi, 1983; Heyns, 2005). According to Szelenyi (1987: 7), these factors 'produced an un-egalitarian system of housing allocation, which produced, and reproduced, the residential segregation of occupational groups'. However, during the transition, as income inequalities became more acute and the gap between different socio-economic groups widened, social and ethnic residential segregation was given new impetus (Kovács, 1998; Węcławowicz, 1998, pp. 55–66; Marcińczak, Musterd, & Stę; pniak, 2012). Poor, unskilled and marginalized people started to concentrate in highly segregated neighbourhoods containing substandard housing. Residential segregation was often accompanied by the lack of adequate urban services including UGS (Kronenberg et al., 2020). In each surveyed city, the highly segregated neighbourhoods (indicated by 5 on map "B") are almost entirely classified into the HDS DSCI class, which means that for this group of people the relative availability of UGS is very low. The average income and educational level of the population concentrated in such areas is under the city-average, while the age structure of the local population varies from city to city.

5. Conclusions

In the last few decades post-socialist cities have faced several spatial challenges, but perhaps the gravest phenomenon among them was suburbanization, when younger people and especially the affluent sought better residential conditions outside the city boundaries. As many authors noted, the mass movements of people from the core-city to the suburbs were often triggered by the lack of green spaces and related leisure facilities (Kok & Kovács, 1999 Sailer-Fliege, 1999; Hirt, 2007; Leetmaa & Tammaru, 2007; Ouředníček, 2007; Kubeš & Nováček, 2019; Zévl & Ouředníček, 2021). The lack of adequate green spaces in contemporary CEE cities can be considered to be the outcome of developments not only during communism, but also before and after state-socialism (Iváncsics & Filepné Kovács).

Before the advent of communism wealthy groups in society lived in

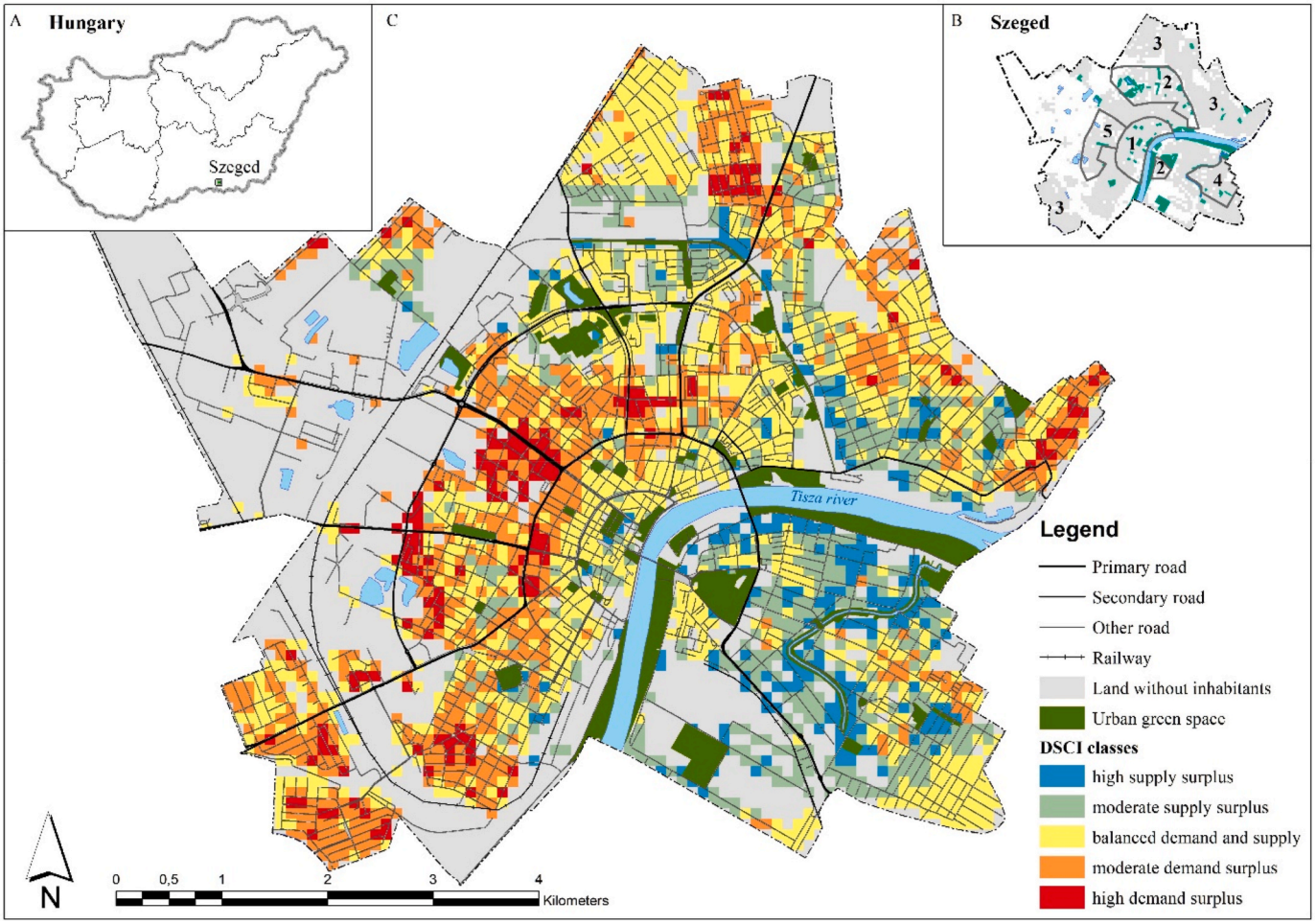

Fig. 3. The geographical visualization of DSCI classes and residential area types in Szeged.

prestigious inner-city neighbourhoods in CEE cities, whereas working class people settled in the outskirts. The need of inner-city residents was satisfied by small-scale green areas (i.e. pocket-parks, gardens), a comprehensive development of urban green infrastructure in planning practice was by and large missing. During communism priority was given to the development of industry and mass production of housing. Housing was proclaimed to be a universal right; simultaneously, housing production became standardised and increasingly concentrated in large housing estates with uniform layouts and amenities. Urban planning focused on choosing the best locations for housing estates and industrial plants, whereas the development of green spaces and other amenities was neglected. The scarcity of green spaces in the new housing estates was only gradually addressed in the subsequent decades. After the collapse of communism, the spatial transformation of CEE cities commenced according to market principles and the neoliberal paradigm: the main task of urban planning was to serve the interests of private investors. As we can see, the development of urban green spaces (UGS) in the 20th century was considered to be a secondary issue in CEE cities, which eventually resulted in an uneven spatial pattern, and thus a high level of inequality in the availability of green spaces. The issue of provision of adequate green spaces in the cities of CEE has gained importance in urban planning strategies only after the EU accession (i.e. first decade of the 2000s.). Since then, local governments have had to pay more attention to the development of the city's green infrastructure including UGS, and to consider seriously such concepts as anti-segregation and environmental justice.

In this paper the spatial disparities of the availability of green spaces in three post-socialist Hungarian cities are analysed. For the purpose of the investigation we introduced a novel method, the demand-supply composite index (DSCI), which allows us to measure the availability of UGS in different types of neighbourhoods. The novelty of the method is that it considers not only the availability of green spaces but also their accessibility by different socio-demographic groups. We consider the DSCI to be a useful tool to explore how legacies of the past and recently emerging socio-economic developments affect the relative availability UGS. Furthermore, with the application of the method we could gain useful insights about green space availability in relation to residential segregation in the surveyed cities (Rufat & Marcińczak, 2020; Łaszkiewicz, Kronenberg, & Marcińczak, 2021).

Our results suggest that despite the recent efforts of local governments to reduce socio-spatial segregation and lessen the effects of path-dependency in the availability of UGS, post-socialist cities can still be characterized by a high degree of environmental inequalities. In terms of UGS availability, major disparities exist both among different socio-economic groups (i.e. better-off, highly educated, and relatively young people vs. poor, unskilled and marginalized people) and different types of neighbourhoods (i.e. newly developed affluent neighbourhoods vs. lower-class outskirts). Our findings suggest that poor initial environmental conditions in large housing estates caused by massive industrialization and rapid urbanization during the 1960s and 1970s (Benkő, 2015; Rufat & Marcińczak, 2020) have been gradually levelled out by green space developments in the subsequent decades. On the other hand, the balanced or moderate demand surplus of inner-city neighbourhoods can be interpreted in the light of ageing and a shrinking population. The emerging disparities of green space availability can be more linked to highly segregated neighbourhoods with a concentration of urban

poverty and new upmarket housing developments of the transition period. Our results also suggest that environmental factors and especially the concept of environmental (in)justice should be more seriously considered by the local governments of post-socialist cities in urban policies and planning in the future if they want to mitigate the effects of inherited and newly evolved patterns of social segregation and disparities of urban green provision (Łaszkiewicz et al., 2021; Nzimande & Fabula, 2020).

Finally, we are aware that the DSCI method has certain limitations. First, we have tested its use only in the case of Hungarian cities: thus, the geographical scope of the analysis needs to be broadened. Second, we have applied the DSCI only in the case of medium-sized cities, yet the capital cities, as well as smaller cities of CEE countries, might have experienced different development pathways and evolution patterns. Therefore, the method should be tested and the analysis carried out in different types of cities in terms of size, location and hierarchical level.

Declaration of competing interest

None.

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