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Exploring the urban land-use patterns and dynamics in Central and Eastern Europe

The post-socialist city has been extensively researched by urban scholars from a political and socioeconomic perspective. However, this research has failed to deliver a thorough understanding of its spatial identity. In this study I aim to delve into this question by providing insights into the spatial characteristics of the post-socialist city in Central and Eastern Europe. The findings reveal that post-socialist cities have experienced considerable urban expansion, with dual residential and industrial/commercial specialisation as well as a multiplication of brownfields. By contrast, there remains a scarcity of green areas, amid an intense sprawling and artificialised urban environment.

Keywords: post-socialist city, urban expansion, land use, residential use, green areas

Introduction

The post-socialist city of Central and Eastern Europe (CEE) represents the spatialisation of vast and tumultuous processes of institutional, political, socio-cultural and economic transformation, resulting from a rather chaotic post-1989 transition to a market economy. When speaking of cities from CEE, one can speak of 'palimpsest' cities. These are cities that accumulate morphological and functional features derived from a succession of non-linear temporalities in their structures. They can be considered to have a distinct model of urban development because, while defined by their post-1989 existence and name, they have a unique spatiality that combines historical spatial legacies with characteristics from more recent urban development stages (i.e. socialist urbanism and massive industrialisation), both of which are doubled by new urban forms, the results of European Union accession, and the transition to the liberal economic market. Thus, the net change in the direction of interactions between former socialist countries has been the main driving force of urban transformations. Favoured by a political context that no longer restricted private actors, urban planning in CEE shifted to more pluralistic and entrepreneurial approaches, both however mostly tributary to investments that focused on higher returns' opportunities, while also attempting to mimic Western Europe planning policies (Tsenkova, 2013). However, in countries that had recently emerged from central planning, this mimicry resulted in structural and organisational chaos: laissez-faire politics. Indeed, while the goal was to increase a city's competitiveness, there were some unforeseen

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consequences, such as the proliferation of brownfields, gentrification of inner-city neighbourhoods and intensification of urban sprawl.

The post-socialist city has been widely researched from the angle of socioeconomic processes. There have been fewer and less extensive studies on its morphological and functional patterns and dynamics. In fact, the literature portrays the characteristics of the post-socialist city as processes rather than as spatial structures. As a result, numerous studies have focused on decentralisation, the restitution of financial and/or real estate assets, the privatisation of the economy and, implicitly, the real estate sector, the rapid growth of the tertiary sector and the end of industrial primacy, and the motorisation of the population, to name a few. It is, in fact, an analysis of post-socialist urban transformation through the processes underlying spatial changes, which is correct. However, the approach remains incomplete, as it does not encompass all of the valence of the concept of the 'post-socialist city'. In this respect, the literature remains limited in defining which are the urban spatial patterns and dynamics specific to the post-socialist city, and how different they are in comparison to Western European cities.

This paper takes on this challenge, aiming to investigate the morphology of the post-socialist city in CEE between 1990 and 2018, with a focus on land-use patterns and dynamics between 2006 and 2018. As such, it reviews the literature first, in order to outline the current state of the art in the study of post-socialist cities in CEE, while discussing the existing limitations. This initial section provides an opportunity to lay out the theoretical framework that will guide the data analysis. It then goes on to present the sample of cities chosen for analysis, as well as the databases used and their caveats. Finally, the methodology is explained, followed by the findings and discussions. These indicate that urban development in CEE is heterogeneous and thus cannot be framed under a single model with morphological and functional patterns that differ depending on the demographic size of the city.

Urban morphology and the study of the post-socialist city: a brief literature review

The post-socialist urban transition is most frequently analysed through the lens of socioeconomic processes and phenomena that are behind spatial processes, rarely making urban morphology and functionality the main entry and thus giving the post-socialist city a well-defined spatial identity. Nonetheless, urban morphology is important in understanding the urban transformation of any city as it provides insights into the configuration, structure and organisation of plots within it, as well as the system of relationships established between them (Batty and Longley, 1994) by employing a variety of methods for analysing urban form and function, methods that demonstrate changes in analytical approach as well as the diversification of tools

and technology (e.g. Geographic Information System), statistical data and the use of complex instruments (Oliveira, 2016). Indeed, over time, urbanisation has transformed the morphology and functionality of cities, resulting in a variety of sizes, land-use types and functions and the analysis of morphometric particularities, on the one hand, and functional particularities, on the other, aid in better understanding current and past spatial transformations of the urban fabric, while also allowing for better convergence of socioeconomic effects. Few studies have used urban morphology as their main point of departure to understand the post-socialist city, instead focusing on socioeconomic processes while indirectly acknowledging the accompanying spatial transformations, but with no quantitative spatial data to back it up. Indeed, the most common transformations identified and analysed are suburbanisation (Kok & Kovács, 1999; Hirt, 2006; Milanovic et al., 2007; Hirt, 2008; Tammaru et al., 2009), segregation and gentrification (Enyedi, 1998; Sykora, 1999b; Sykora & Bouzarovski, 2012; Kovács et al., 2013; Galuszka, 2017; Malý et al., 2020) deindustrialisation Kiss, 2007), and real estate privatisation (Pichler-Milanovich, 1994; Hausserman, 1996; Kovács, 1999; Kreja, 2004). Nonetheless, spatial patterns are rarely discussed and are derived indirectly from socioeconomic processes, with no significant quantitative spatial data included.

Consequently, because of the lack of quantitative measures that allow the assessment of the multidimensional profile of post-socialist urban areas, 'chaos' frequently appears as the main driver of the spatial evolution of CEE cities in the post-1990 period (Bérard and Jacquand, 2009; Staniszkis, 2009). 'Chaos' is frequently used as an allegory to describe the systemic disorder that appears to have dominated the development of post-socialist CEE cities, whether institutional (Ticana, 2013), socioeconomic (Totelecan, 2010) or spatial (Ianoş et al., 2012).

In terms of spatial urban changes, a review of the literature reveals several frequently cited factors: the densification of the urban core, which is strongly linked to its tertiarisation – a shift from the primary and secondary sectors to services – (Sykora, 1999a; Sykora et al., 2000); a multifunctional zoning that is sometimes chaotic as a result of an initial ad hoc urban planning (Sykora et al., 2000; Hirt, 2013; Hirt, 2015); the massive reduction of open spaces, including green spaces, ensuing numerous legislative shortcomings (Hirt and Kovachev, 2006; Sandu, 2017); the abandonment or minimal conversion of former industrial zones and the tertiarisation of peripheral zones (Kiss, 2007; Jigoria-Oprea and Popa, 2017).

The phenomena of urban sprawl – namely the development of new residential neighbourhoods as well as nearby shopping centres in the outskirts – are the processes most often studied in the literature, serving as the leitmotif of post-socialist functional and morphological changes (Suditu et al., 2010; Grigorescu et al., 2012; Slaev et al., 2018; Kovács et al., 2019). However, there are few quantitative studies that examine post-socialist cities over a longer period of time than the post-socialist era (Mykhnenko

and Turok, 2008) and the majority of those are limited to certain countries in the former communist bloc (Schmidt et al., 2015). There is also a dearth of studies that propose schematics of what post-socialist spatial land-use patterns are (Sailer-Fliege, 1999) or how divergent or convergent the spatial process of urbanisation in CEE with respect to Western European cities is (Taubenböck et al., 2019). Indeed the analysis of Schmidt et al. (2015) provides a major insight into the transformation of urban land-use within the cities from five countries from CEE, highlighting that increased urbanisation rates were identifiable since the early stages of the post-socialist transition, especially in suburban areas rather than the urban cores, regardless of the city's size.

All of this research describes a shift to a less monocentric structure. More precisely they emphasise a transformation from a compact city to one confronted with the phenomenon of uncontrolled urban sprawl, but without making morphology a key entry. As such, this study delves into these questions by trying to update the spatial urban characteristics of post-socialist cities in CEE in terms of urbanisation rates and land-use patterns, while also proposing a methodological frame for the study of cities and urban planning beyond the findings on post-socialist cities. Its main goal is to call into question the concept of the post-socialist city through its spatial identity, and to attempt to develop a general model/profile of what characterises its internal structure in terms of land-use patterns and dynamics, using GIS and quantitative analysis. I argue that viewing the post-socialist city mostly through the lens of socio-economic reorganisation and restructuring, which underpins the emergence of new urban forms, may result in an incomplete analysis incapable of proposing effective solutions for overcoming 'the intermediate stage'. This is the stage in which post-socialist cities are nowadays, relative to their alignment with the morphological and functional particularities of Western European cities.

The aim is to demonstrate that, after thirty years of post-socialist transformation, the urban morphology of Central and Eastern European cities has converged towards that of Western European ones, but that this convergence has been unequal and concerns, fundamentally, the largest cities, which have attracted the highest levels of investment and experienced the highest economic growth. By contrast, the process of transformation has bypassed the majority of medium-size and smaller cities in Central and Eastern Europe, which in some cases have remained anchored – at least in terms of their morphology – in the socialist past.

Finally, the paper synthesises and standardises the consequences of structural reforms (political, socioeconomic etc.) on the urban fabric. The objective here is to uncover both a general spatial pattern at the level of CEE, as well as specific patterns that may be induced by demographic city size. As a result, it seeks to add a spatial dimension to the already advanced socioeconomic and political analysis of the post-socialist city in CEE.

Study area, data and methods

The study area

I cover ninety-three cities from eleven countries to examine the morphological and functional identities of cities in CEE (Figure 1). I keep in mind that there is no 'official' definition of what is recognised as CEE. The eleven countries chosen are ex-communist countries that have joined the European Union. The selection of a rather broad group of CEE countries allows for the development of a morphological and functional model of urban spatial patterns and dynamics for this region, or for what the literature refers to as the post-socialist city, which lacks a quantitative model but has several descriptive ones.

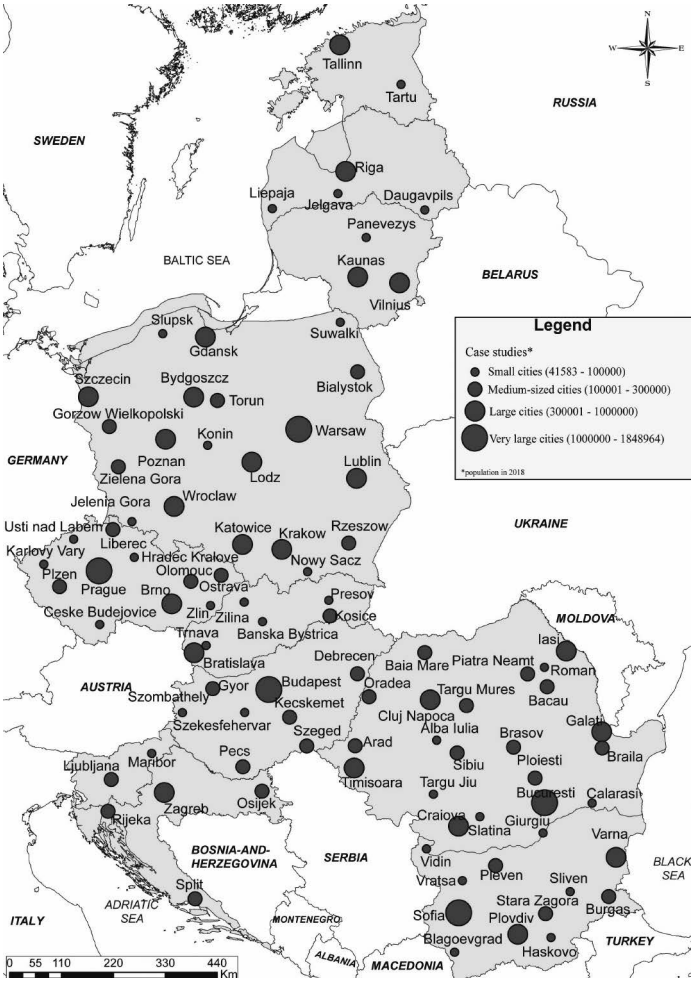

Figure 1 The study area
Source: Eurostat (2020a; 2020b)

The ninety-three cities were chosen based on demographic and functional characteristics, as well as their position in the national hierarchy. However, city selection was constrained as well by limitations in the availability of Global Monitoring for Environment and Security (GMES) Urban Atlas spatial data. GMES data availability is a key requirement because it is the only database that can provide information on land-use dynamics. The cities are divided into four classes: very large cities (population over 1,000,000 inhabitants), large cities (300,000–1,000,000 inhabitants), medium-sized cities (100,000–300,000 inhabitants), and small ones (under 100,000 inhabitants). For each class, I include a number of cities proportional to the total population of the country. I also double the demographic criterion with the functional similarity. Cities have been selected in such a way that their spatial distribution within each country is equitable (Figure 1).

It should be noted that the spatial units of analysis are the Urban Morphological Zone (UMZ) and the Functional Urban Area (FUA), which were chosen to standardise the analysis and allow for comparisons. The European Environment Agency established the UMZ in 2004, to enable for a morphological and functional comparison of cities on a European scale. It is described as consisting of continually developed regions, as defined by the Corine land cover classifications, with a maximum distance of 200 m between them (Simon et al., 2010). The FUA is another concept developed by the Institute of Environmental Management and Territorial Planning, with the goal of harmonising studies on European urban areas. The FUA is described as an area polarised by an employment centre – a densely populated urban centre – that polarises the population of neighbouring areas (Guérois et al., 2014). The FUA encompasses the UMZ, and both were chosen as spatial units of analysis to examine morphological and functional patterns and dynamics such as urban sprawl or, on the contrary, densification of the city core.

Materials and methods

The use of appropriate databases is a key consideration for this study. A city's morphological and functional structure is not fixed in time or place. Rather, it is dynamic in response to social, economic, political and historical events. Any quantitative analysis conducted for CEE cities requires the use of harmonised and reliable databases capable of providing sensible land-use models/profiles that will show the general spatial patterns of the internal structure of the city and could then shape and/or guide urban planning at the local, national and even supra-national levels. To that purpose, I employ the GMES Urban Atlas database (EEA, 2018b) and the Imperviousness (IMD) (EEA, 2018a) and Global Human Settlement (GHSL) (Corbane et al., 2018) databases to derive urban spatial dynamics and particularities of the urban fabric, as well as different land-use types, in CEE. However, it should be kept in mind that there

are some drawbacks. To begin with, the GMES Urban Atlas database, which is used to derive the land-use patterns and dynamics, only provides data for the years 2006, 2012 and 2018 for urban areas with more than 100,000 inhabitants, as defined by the Urban Audit on a scale of 1:10,000 for the reference year 2006. Furthermore, the same class incorporates both commercial and industrial zones without distinguishing between them. It would have been preferable to have separate classes for these two types of land use in the study of the post-socialist city, as they symbolise the post-socialist change's leitmotifs. Despite this setback, this database can still be employed to develop a model for the internal structure of cities based on land-use spatial concentration patterns for the year 2018, which could provide useful insights into the real internal layout of major urban regions.

When it comes to methodology, analysing a dynamic structure requires a flexible and comprehensive approach. Hence, I use radial analysis to construct multiple profiles. The profiles show the percentage of new built-up areas in FUA between two points in time (1990 and 2018). I also use the percentage of total built-up area in FUA in 2018. The analysis also contemplates the spatial clustering of land-use types within FUA in 2018, as well as the spatial clustering of new land-use types within FUA from 2006 to 2018. It should be noted, that for this analysis, the inner urban area of the post-socialist city is bounded at a maximum radius of 24 km, which is the maximum extent of the UMZ of the cities studied. The periphery of the post-socialist city is considered to extend from 24 km to 92 km from the centre. Four profiles were created: one for very large cities, one for large cities, one for medium-sized cities and one for small cities. A final profile was added to represent the overall (average) urban land-use patterns and dynamics. Because CEE is still a territory developing at different rates, there are undoubtedly differences between (very) large cities, which are polarising urban and socioeconomic development, and medium-sized and small cities. Consequently, analysing just a general profile that shows the average built-up percentage could not capture many urban specificities.

A concentric model was used to standardise the analysis. This approach echoes traditional concentric urban models (Alonso, 1964; Burgess et al., 1967), which established that radial analysis, while a simplified method, would advance the understanding of urban patterns. The method, however, has significant drawbacks, such as its inability to capture some of the sectorial functional specialisation inherited from the socialist era in detail. Nonetheless, it represents a step forward in terms of providing the post-socialist city a quantitative spatial identity.

The radial analysis was carried out by forming multiple rings buffers every 100 m until a maximum radius of 92 km, which is the maximum area of the FUA of the cities studied. The barycentre is identified as the city's centre. The general profile showing the land artificialisation pattern was produced by calculating the average percentage of built-up area for each ring buffer across all ninety-three cities surveyed

in 2018.[1] Aside from the general profile, the same approach was used to derive four more profiles for each of the city types previously stated. The profiles illustrating the new artificial areas constructed between 1990 and 2018 were generated using the same rationale.

The Location Quotient (LQ) (see Feng and Minhe, 2011 for methodological details) was calculated using the same multiple ring buffers as before, but this time individualising four main types of land use (residential zones, industrial and/or commercial zones, land without use, e.g. brownfields, and green urban areas) to derive the profiles illustrating the spatial clustering of (new) land-use types. When reading the LQ, a number above one indicates above-average spatial clustering, while a value below one indicates the opposite. It is important to note that the profiles illustrating spatial concentration in 2018 cover all ninety-three cities. However, data for the profiles depicting the spatial concentration of new land-use types built between 2006 and 2018 is only available for seventy-three of the ninety-three.

To summarise, this paper attempts to bring together a methodology fundamentally embedded in urban geography, which analyses urban morphology and functionality using quantitative statistical analysis and GIS tools. The main objective is to provide a quantitative insight into the urban particularities and changes in CEE while demonstrating that there is more than one urban development trajectory. It will also show that, while similarities can be observed, there are also substantial variations (e.g. differences in post-socialist cities related to size may affect access to certain services and amenities) that must be accounted for in international and national urban policies.

Results and discussions

Urban morphology changes slowly – even in a context of very rapid political and economic changes – and, therefore, transformations in the different tranches of the intervening period are less susceptible to stand out. This is also the case when looking at the built-up area changes in cities from CEE since 1990. The majority of the transformation of cities in CEE took place in the early stages of the post-socialist transition, between 1990 and 2006, in line with Schmidt et al., 2015. During this period, many of the largest cities in the region experienced considerable transformation in their urban morphology, bringing them closer to the standards of Western European cities. Also as Schmidt et al. (2015) observed, changes slowed down post-2006. However, the pioneering work of Schmidt et al. (2015) concentrated mostly on large cites and included only several countries from CEE. The economic crisis that affected certain parts of CEE countries also contributed to slow down the process of urban transformation. But even in Poland – a country notorious for not experiencing a recession

1 Land artificialisation is the transformation of an agricultural, natural, or forestry soil into impervious surfaces.

post-2007/2008 – the transformation in the morphology slowed down. As such, the sketching of profiles that capture the morphological and functional particularities is favoured to add knowledge to an already extensive literature on socioeconomic changes in the urban area of CEE, as highlighted earlier.

Starting with the morphological particularities, namely the spatial concentration of built-up areas within FUA, the general profile allows the identification of a highly artificialised urban core until (over 70 per cent) around 1.8 km from the barycentre, after which the land artificialisation decreases steadily towards the outskirts, with only a few slightly noticeable peaks around 30, 53 and 65 km (Figure 2). It should be noted that the logarithmic scale was preferred relative to a linear one in all figures, because it allows for an easier observation of the differences when there is a wide range of values.

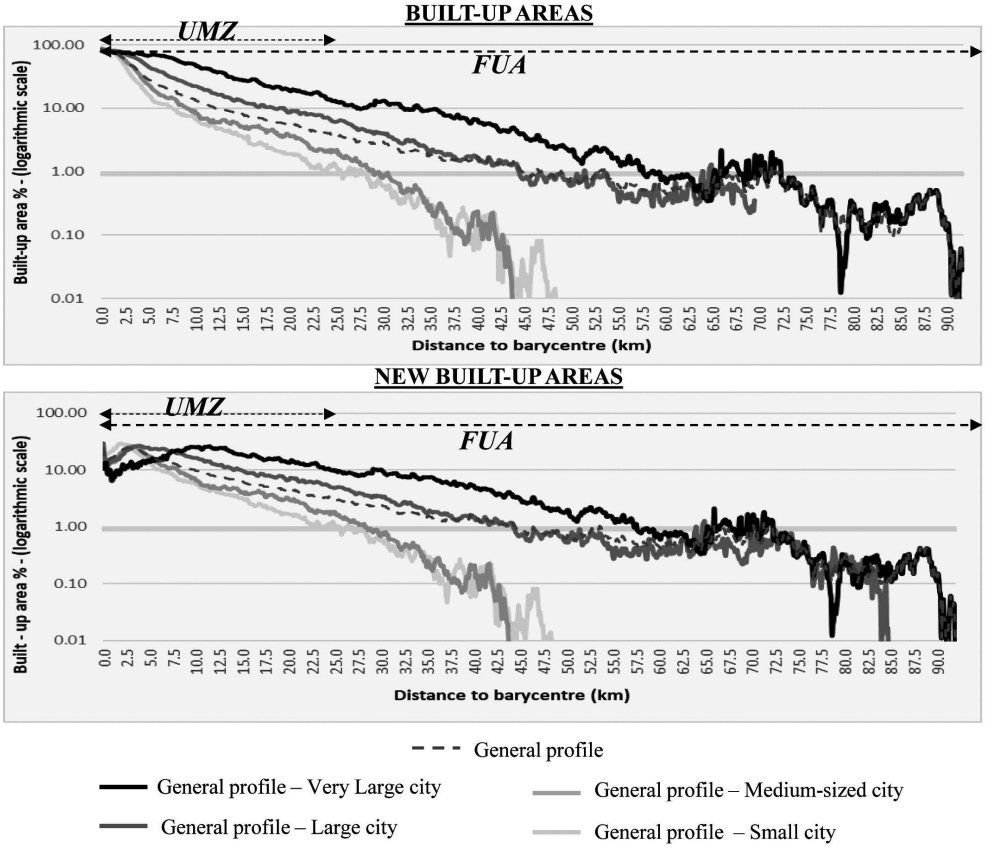

Figure 2 Artificialisation profile(s)
Source: Corbane et al (2018); EEA (2018a)

As expected, very large cities exhibit a different pattern of built-up area spatial concentration, with highly artificialised areas (above or around 70 per cent) until 5.7 km from the barycentre, but with the same steady declining tendency towards the periphery, albeit less abruptly. There are several small percentage increments, particularly visible towards the outskirts (e.g. 30 km, 45 km, 53 km, 65 km) indicating an intensive and place-consuming urban sprawl phenomenon. Some minor peaks may be found in all of the other city profiles. They are less prominent, however.

The large city profile also demonstrates a higher overall degree of land artificialisation, both in the inner and outer periphery. There are significant differences in the degree of land artificialisation for the four types of cities: very large cities have nearly twice the proportion of built-up area as large cities, which, in turn, have twice the percentage of built-up area as medium-sized ones. The difference between medium-sized and small cities, on the other hand, is less pronounced. Finally, while the general profile reveals a land artificialisation that extends until 92 km, the four types of cities exhibit significant differences, with very large cities extending until 92 km, but large cities only until 85 km, medium-sized cities until 44 km, and small ones until 48 km. These results are extremely dependent on the FUA limit as well as the natural characteristics of the area in which a city is located. This could force a predominantly linear urban growth, albeit with a very low degree of land artificialisation (e.g. Piatra Neamț in Romania). In fact, at 7.5 km from the barycentre, the degree of land artificialisation decreases below 10 per cent for small cities, and at 9 km for medium cities. This occurs at a distance of 33.5 km in the case of very large cities and 19.5 km in the case of large ones. For the latter two classes, this is the result of increased and mostly uncontrolled urban sprawl. As Tsenkova and Budic (2006) point out, it arises from a growing motorisation of the population and its desire to escape the highly artificialised urban core, while remaining as close to and connected to the cities' main places of interest as possible.

Thus, the intensely artificialised urban core and the continuous decreasing trend of the built-up area towards peripheral areas with a few small peaks show a model of a city which is rather similar to that of Western Europe, although the latter, as Guérois (2003) shows, has a degree of land artificialisation of 100 per cent or close to it in the urban core and its surrounding areas and in the outskirts the urban sprawl is more pronounced.

In terms of new artificial areas built between 1990 and 2018, the barycentre for all city profiles shows a low percentage. The notable exception is the large city, which exhibits a consistent percentage of new artificialised areas (3 per cent) until around 1.3 km, with the percentage increasing to a peak at 6.4 km, before beginning to fall slowly, but steadily towards the outskirts. Between 4 km and 8.5 km, a plateau can be seen, with the proportion remaining constant at 20–22 per cent.

In both the medium and small city profiles, the percentage of new built-up areas reaches a peak at 3.7 km and 2.8 km, respectively, before declining continuously as we

move away from the barycentre. Built-up areas drop sharply as we approach the limit of the FUA. A plateau is also observed between 2.7 km and 4.4 km in medium-sized cities and between 1.8 km and 3.6 km in small ones.

In the case of very large cities, the inner urban area does not witness a significant increase in new built-up areas, with the percentage of new artificialised areas rising from 4.5 km and flatlining between 7.7 km and 14.1 km, with a percentage ranging between 20–22 per cent. Despite the fact that the decline after the plateau is sharp in the other three types of cities, the percentage of new built-up areas in very large cities remains above five until 40 km. In fact, when compared with other cities on the outskirts, very large cities display a twofold, if not higher, degree of new land artificialisation. A percentage more than five is observed in the large city until the inner outskirts (~25 km), whereas it is observed in the medium-sized and small cities until ~12 km and ~10 km, respectively. Finally, towards the FUA limit in (very) large cities, new built-up areas display a tooth saw evolution with a rapid and continuous decrease in percentage.

The distribution of new built-up areas (Figure 2) suggests that the post-socialist city is not only subject to the phenomenon of urban sprawl, but it is also densifying the urban core and inner-city periphery. Although urban sprawl is a characteristic of post-socialist urban growth, it is important to note that the percentage of land artificialisation in inner-city zones is also increasing significantly. As such, urban sprawl is undoubtedly the outcome of uncontrolled urban development, but it is also impacted by a decrease in the availability of open spaces in an already highly artificialised urban core (Schmidt et al., 2015). A more active development of (very) large cities is not surprising, given that CEE is still predominantly characterised by a macro-cephalic urban development, with capitals and major cities polarising the majority of investments and resources (Zdanowska, 2018). As shown in the profiles and also highlighted by Tsenkova and Budic (2006), the effect of the power play of demand and supply in inadequately and insufficiently regulated liberal economic markets is a rising and spatially extended land artificialisation, sometimes insufficiently controlled and accounted for.

It is also worth noting that when the built-up area patterns are analysed not only by demographic size, but also by country, significant cross-country differences are not particularly strong, at least in terms of the overall allure of the land artificialisation profile (Figure 3a).

Across all the CEE countries with more than two cities in a class, there is evidence of the existence of a dense artificialised metropolitan centre that gradually decreases towards the periphery. The tooth saw pattern towards the FUA boundary attests to the occurrence of urban sprawl in all of the countries studied. Even when analysing medium and small-sized cities by country, no significant differences can be found (Figure 3c and 3d).

When looking at large city built-up area profiles by country, some differences can be seen, with Poland having a higher degree of land artificialisation. Polish large cities

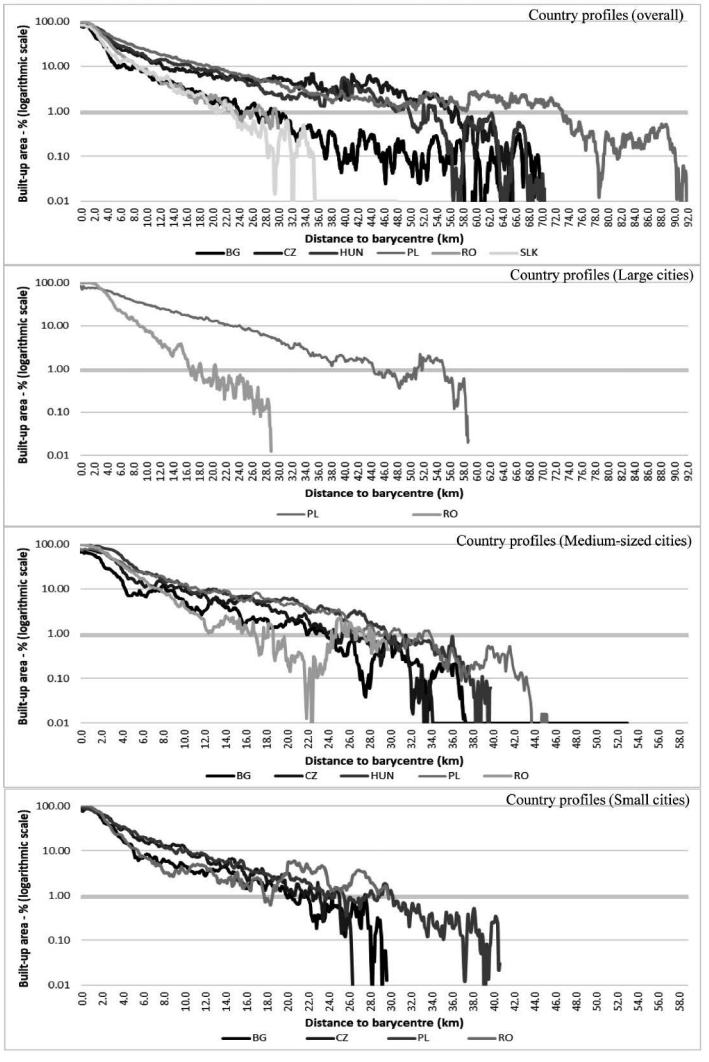

Figure 3 Country profiles: (a) overall, (b) large, (c) medium-sized and (d) small cities
Source: Corbane et al (2018); EEA (2018a)

are also far more extensive than Romanian cities (Figure 3b). This difference may be to geographical and historical differences. Romanian cities are close to the urban morphological model of southern Europe, with cities that are more compact than in other Western European countries (Guérois, 2003). In fact, the main difference (valid for the entire CEE) compared to the Western model is the absence on the profiles of a 100 per cent degree of land artificialisation in the urban core (Guérois, 2003).

When looking at the functional particularities, residential zones display a dual trend of spatial concentration, both in the urban core and the outskirts, with a stronger clustering around the city core (Figure 4).

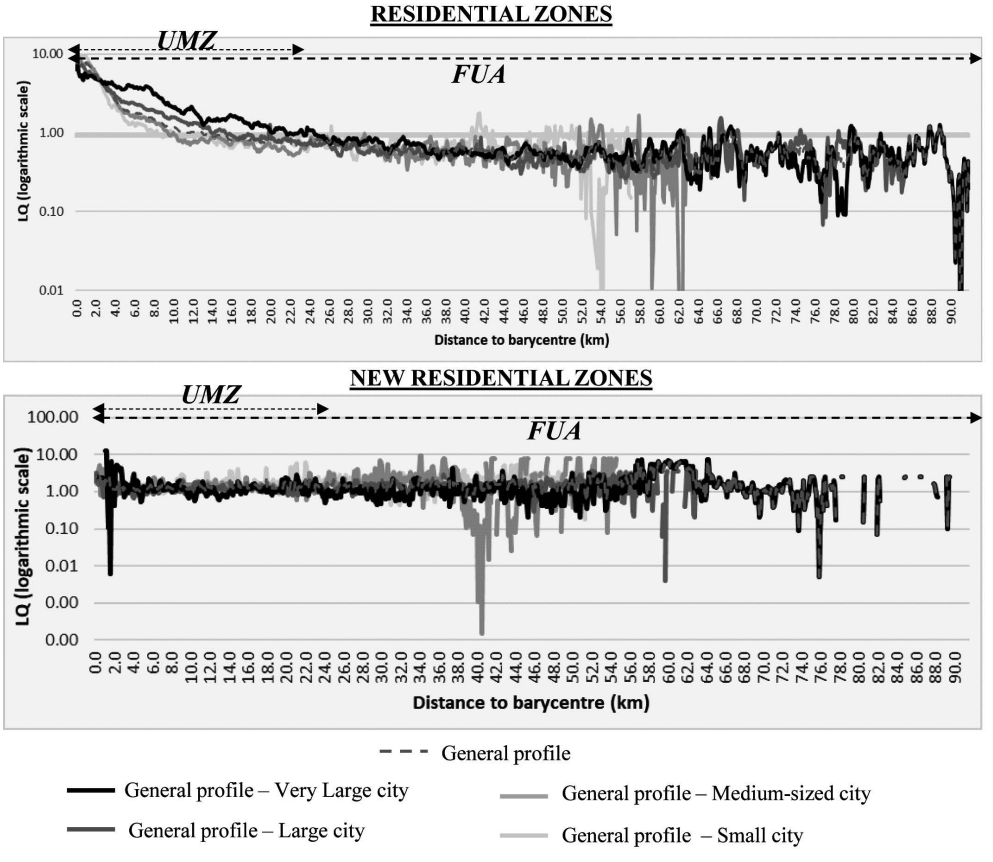

Figure 4 Residential zones' spatial patterns and dynamics
Source: EEA (2018b)

The residential sprawl is noticeable, with the LQ dropping more or less steadily until nearly 40 km, when both an uptrend and a downtrend alternate. This is a direct result of a change in the population's lifestyle and mobility in a desire to copy Western values, namely a preference for detached housing and an increased use of personal cars, but also of the new dynamic imposed by the new economic order, land prices and income changes (Milanovic et al., 2007; Salvati & Carlucci, 2015). Last but not least, there is a rapidly decreasing surface available in the urban core and even the inner-city peripheries. Once again, very large cities stand out, with the lowest LQ values for the city core among the five profiles, but, nevertheless, the highest among its own values, as well as greater values for both the inner city and the periphery, starting about 4 km from the barycentre. It should be noted that for all cities, regardless of

population size, the highest values for the LQ for residential areas are recorded in the barycentre and its immediate vicinity until around 4 km for all cities, with the exception of the group of very large cities, which, as mentioned earlier, continues to have high values towards the inner periphery.

The new residential zones (Figure 4) retain the same spatial concentration pattern both near the urban core and on the outskirts. However, while still significant, LQ values are lower in the immediate vicinity of the barycentre than in the outskirts, possibly due to land artificialisation saturation as noted by Schmidt et al. 2015, high demand for office and retail spaces (Andrews, 2005) and/or gentrification (Tsenkova, 2006; Sykora and Bouzarovski, 2012; Hirt, 2013). Furthermore, due to huge land price variations, the high demand for space in the urban core may explain the clustering of new residential zones towards the outer urban core and outskirts (Milanovic et al., 2007). Furthermore, the higher values observed in the outer urban core, particularly in (very) large cities, may indicate one of the areas of concentration of the former socialist large housing estates, making it an attractive and profitable area for new residential investments due to the presence of services (road, water, electricity networks, etc.) (Stanilov, 2007a). Overall, high LQ values for new residential areas, for all city profiles, attest to the significant presence of urban sprawl in post-socialist cities.

Along with the growth of the housing real estate market, the post-socialist city has witnessed significant growth in the tertiary sector (Hirt, 2013) and a deep transformation of the industrial sector. This is clearly a product of the change from a centralised economic system to a free market-based economy, as well as a result of Western investors' drive to economically 'conquer' new territory.

The profile indicating the spatial concentration of industrial and/or commercial zones (Figure 5) demonstrates that the LQ values for industrial and/or commercial zones are significantly higher on average than the LQ values for residential zones. Thus, despite the general negative demographic growth rate that characterises CEE countries (Mykhnenko and Turok, 2008; Schmidt, 2011), the former predominate in terms of the main land-use types, hinting at an imbalance between offer and real demand.

The industrial and/or commercial zones are particularly abundant in the city core, gradually decreasing towards the periphery, though more abruptly in medium and small cities. Again, very large cities have distinct patterns, with a highly specialised barycentre followed by a significant drop in the immediate vicinity before increasing again from 1 km. The tooth saw trend is visible again in the outskirts, implying an industrial and commercial development, in addition to the residential one. Overall, these spatial clustering patterns are the result of both the growth of large shopping malls and the construction of new large industrial parks in the outskirts of the cities (Sailer-Fliege, 1999; Stanilov, 2007b), as well as of an attempt to replicate the spatial pattern of Western Central Business District (CBDs) (ESPON, 2012; Sager, 2011) into an already overcrowded (both residential and commercial) urban core.

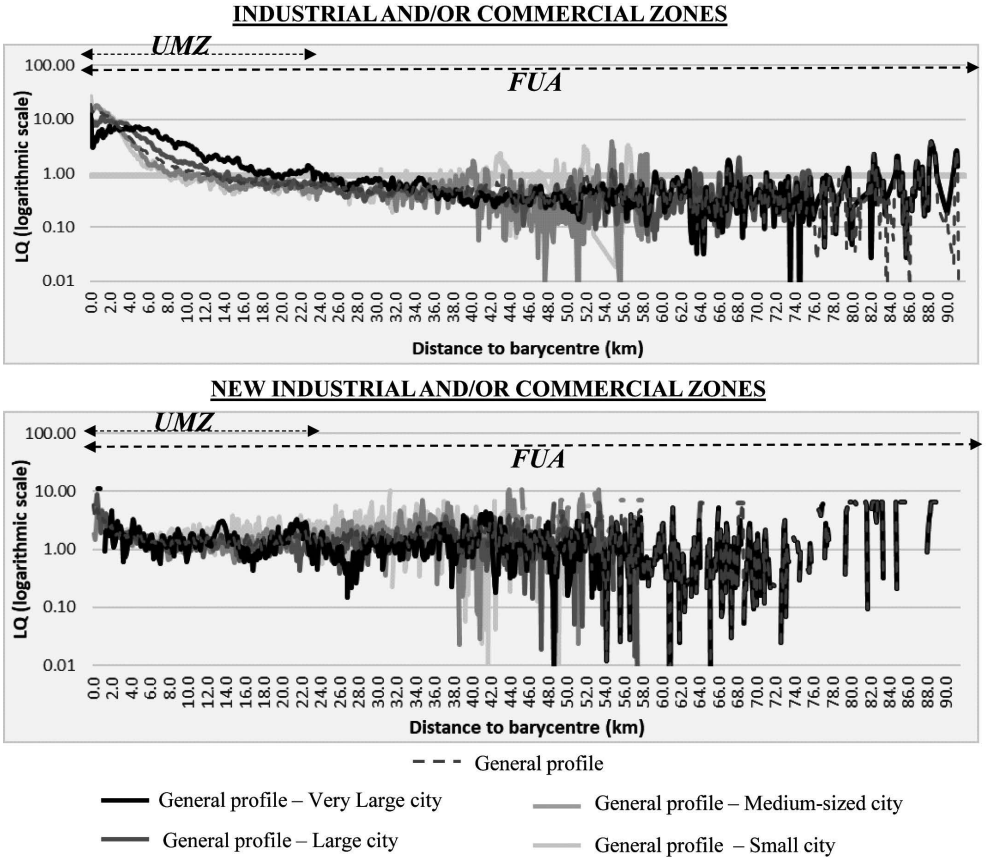

Figure 5 Industrial and/or commercial zones' spatial patterns and dynamics
Source: EEA (2018b)

The spatial patterns of clustering of new industrial and/or commercial zones, primarily around the urban core and the outer-city periphery, reflect a shift toward a liberal market (e.g. tertiarisation of the urban core), as well as a desire to mimic 'Western' values (e.g. large shopping and office areas). All in all, there is an ongoing effort to (re)align to functional global processes (Milanovic et al., 2007). The expansion of the industrial and/or commercial zones, as well as residential zones, as illustrated before, on the outskirts of cities is also pushing cities in CEE to resemble Western European ones more (Sager, 2011; ESPON, 2012).

There is, however, an absence of new industrial and/or commercial zones for all but the small city near to the urban core, with very large cities having the greatest gap until 400 m. In medium-sized cities, this absence is confined to the barycentre. This

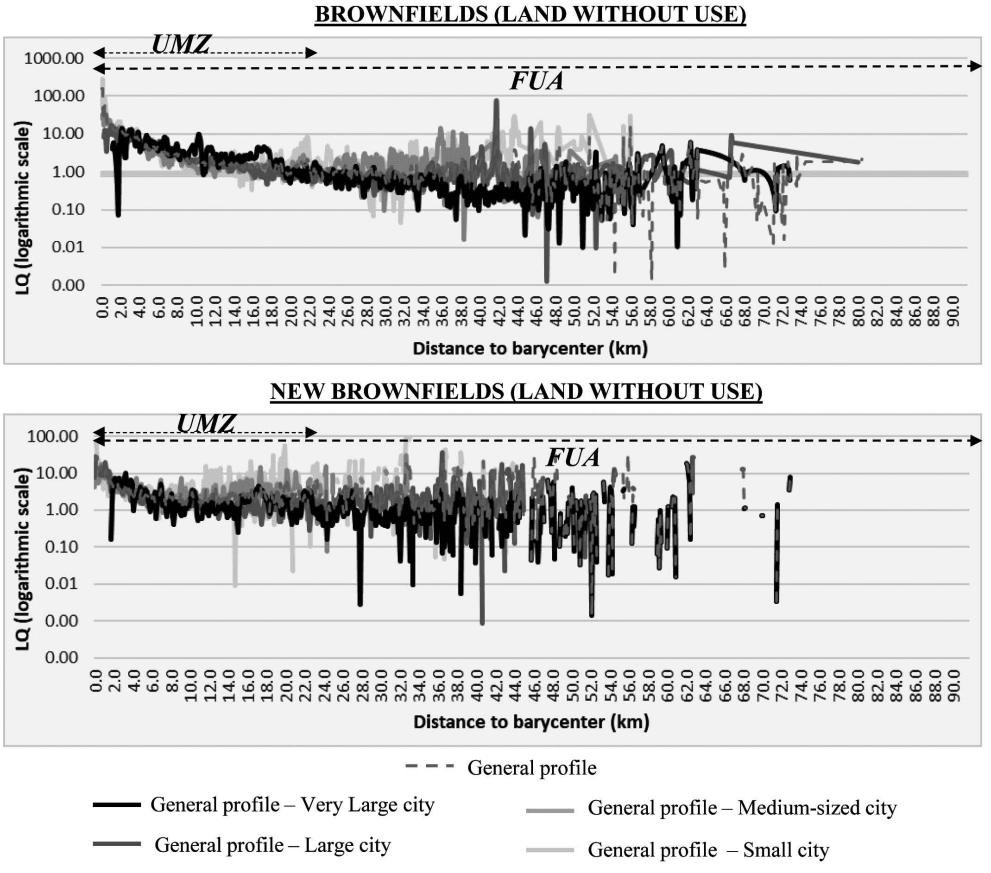

Figure 6 Brownfields' spatial patterns and dynamics
Source: EEA (2018b)

gap could indicate a trend toward both the preservation of the urban core's historical legacy and the aim to limit the land artificialisation increment. However, far too often the hasty end of industrial primacy, accompanied by a focus on tertiarisation of the economy, has resulted in an unsustainable use of open space and the multiplication of abandoned land (brownfields) (Figure 6) as a result of the reduced reconversion or rehabilitation of former socialist factories that ceased to function because of lack of productivity (Jigoria-Oprea and Popa, 2017).

Deindustrialisation is a post-socialist transition feature whose main negative spatial impact has been the multiplication of various types of brownfields (e.g. industrial, military and administrative) that have fractured the urban post-socialist landscape (Kunc et al., 2014). The medium-sized and small (industrial) cities –especially the

latter, which were a paradise for the market economy and competitive mechanisms – were the hardest hit. Nonetheless, a review of the profiles depicting the spatial patterns of concentrations of land without use (brownfields) (Figure 6) revealed an even and continuous distribution, with its most significant peaks located both in the city core and on the outskirts of the post-socialist city.

Overall, small and medium-sized CEE cities face a more challenging problem in terms of finding effective solutions to ever-growing brownfields (Kunc et al., 2014), with peaks in both the inner and outer city outskirts. However, even (very) large cities are still dealing with the legacy of a planning system where land had no price and the logic of developing new industrial areas was more a question of ideology than real progress and economic benefits (French and Hamilton, 1979). However, it is also a result of the urban system's hierarchical system (Filip and Cocean, 2012), with (very) large cities having an advantage due to their larger capacity to attract many potential investors and therefore funds that can be employed to restore the lands without use. The prior point of view is supported by the scarcity of brownfields around the urban city centre in very large cities. It is a matter of having the financial resources to convert abandoned lands. But it is also a matter of lucrativeness, as empty land in large city central zones is clearly of interest to private commercial operators due to high accessibility and increased polarising capacity (Rodríguez-Pose and Storper, 2020).

The new brownfields display the same dual trend of concentration around the city core and on the outskirts of the city, with small and medium-sized cities standing out through higher peaks. Very large cities have a distinct tendency, with additional undeveloped land not being detected in the city core and its overall spatial concentration being the lowest of the five profiles. The explanations are the same: because they are more dynamic and financially free, (very) large cities have found more ways to deal with this challenging communist legacy. Nonetheless, it is an important problem for the post-socialist city for which national authorities and urban planners have yet to find appropriate and efficient solutions, remaining the main drawback in the development of former industrial socialist cities, as well as an important source of spatial and/or architectural fragmentation of any post-socialist city's urban landscape. Brownfields, like major housing estates, are an integral aspect of the post-socialist urban fabric that is difficult to dislodge in order to allow for more coherent urban growth.

Finally, green urban areas (Figure 7) show a strong downward trend towards the inner-city periphery (less visible in extremely large cities) as well as a scattered spatial concertation pattern commencing at 15 km. Again, there is a distinction between (very) large cities and medium and small-sized cities, with the former having an advantage, at least in terms of inner-city periphery. There is a resemblance, with all four types of cities investigated demonstrating high spatial clustering around the urban core (up to 7 km from the barycentre). It should be noted, however, that the very large city in CEE has a more uniform clustering of green urban areas until 7 km, with a

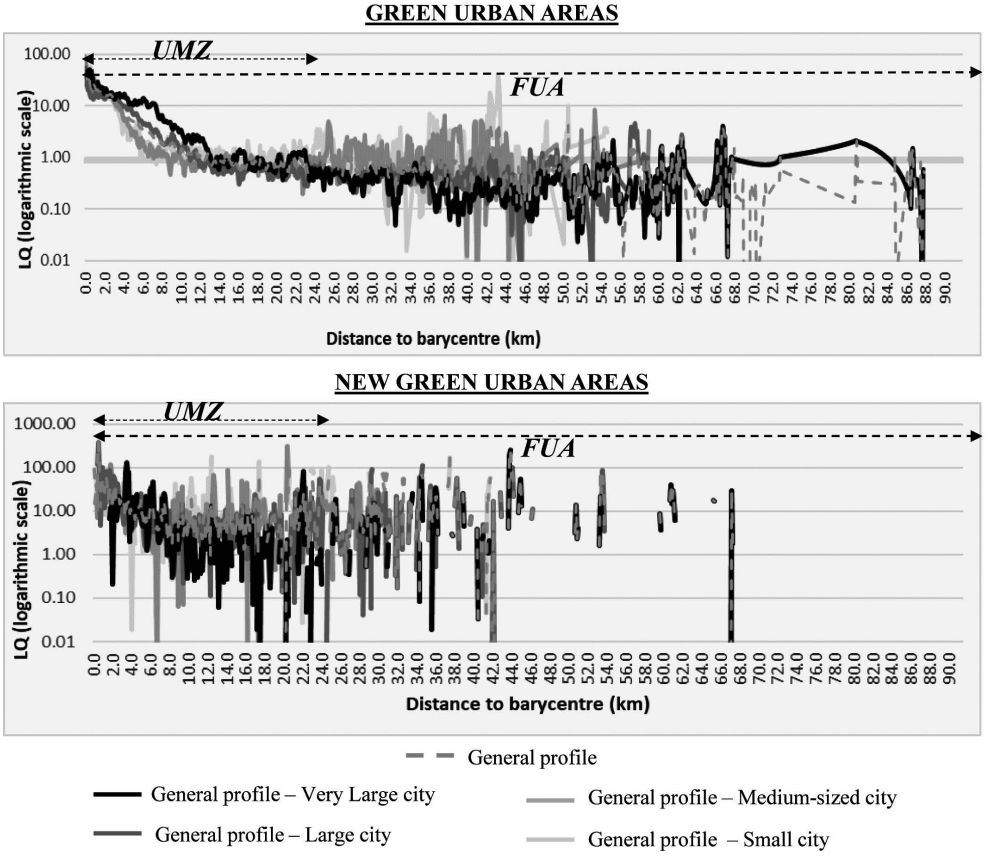

Figure 7 Green urban areas' spatial patterns and dynamics
Source: EEA (2018b)

less steep decrease from barycentre throughout the inner urban area. The other three types of cities, in contrast, have a high clustering of green urban areas in the urban core, which then rapidly declines, despite remaining higher than the average.

Nonetheless, the overall strong declining trend, as well as the unequal spatial clustering, highlights the idea that, in a context where the focus of the post-socialist transition was on economic gain, green urban spaces were frequently ignored. By leveraging land restitution laws as well as a loophole in urban socialist plans that did not identify small green areas within the perimeter of a residential area as an individual category (open space), but rather considered them to be part of the residential complex, urban planners and stakeholders are able to convert them into new housing or even commercial areas without modifying their use (Hirt and Kovachev,

2006). This has led to a significant reduction in green areas in most post-socialist cities, making them subject to negative externalities.

The availability of green urban spaces decreases as we move away from the central zones (Figure 7). Consequently, size differences in post-socialist cities may limit access to certain services and facilities, such as green areas. This is a crucial issue urban planners should consider in order to ensure a higher quality of life and to align with the aims required for resilient and sustainable development. Green urban areas should be regarded as a priority to invest in for post-socialist cities, rather than as open spaces available for land artificialisation (Sendi et al., 2009), as they provide environmental and ecological benefits, as well as aesthetic, social and economic benefits within a model post-socialist city (Haq, 2011) whose degree of land artificialisation is constantly increasing.

The spatial patterns of clustering for the new green urban areas (Figure 7), on the other hand, indicate a heterogeneous tendency with several highs and lows, as well as multiple gaps. The majority of new green urban areas are being developed within the city core and inner-city periphery, with fewer new green spaces on the outskirts, although the need for such spaces is also growing. It is important to note that for the very large city, there are no new green urban areas until 1.6 km, with the gap repeating itself for the large city and medium city but only until 400 m and 100 m, respectively. Nonetheless, there are virtually no new green urban areas extremely close to the barycentre in either the medium or small cities (between 400 m and 700 m and 400 m and 800 m, respectively). This scattered concertation is a result of the limited space allocated or available, and frequently manifests itself in small and fragmented green urban zones, if at all (Hirt and Kovachev, 2006). These green zones are not easily accessible to everyone and do not meet genuine demands. This translates into low green areas per capita for cities in CEE, regardless of size (Sandu, 2017; Csomós et al., 2021). Even in (very) large cities, population and, in particular, built-up areas rise, but green urban areas stay unchanged (in the best-case scenario) or even decrease. The focus is clearly on other types of land use with which greater economic benefits may be attained, disregarding health and social issues.

Conclusions

The study's findings describes a post-socialist city in evolution that retains some of the characteristics imposed by its socialist heritage (large housing estates, brownfields, etc.) but also shares similarities with the (Western) European City (residential and commercial/industrial sprawl). The effect of the new neoliberal economic order is obvious in terms of the spatial clustering of new residential complexes in the inner and outer-city periphery, as well as a dual tendency of spatial concentration of (new) commercial and industrial zones within the urban core and in the outskirts. Nonetheless, communism has left its most lasting impact on the inner-city periphery,

namely massive housing estates, while scattered brownfields highlight the difficulty these cities experience in reconciling the communist legacy with the transition to a free market economy. While these morphological and functional spatial patterns are similar to those of Western European cities, the drivers behind them are not always the same, resulting in a palimpsest city characterised by intricate morphological and functional juxtapositions, transposed into continuities, but also spatial discontinuities due to a frequently forgotten or ignored urban socialist legacy.

The hierarchy of cities within the national network also entails several dissimilarities and appears to be significant in shaping the urban morphology and functional coherence and dynamics of the post-socialist city. Because of their integration in international socioeconomic networks, (very) large cities are more dynamic and appear to be more coherent in terms of urban morphological and functional characteristics. Certainly, the degree of soil sealing is higher, but there are more parks to be found, at least until one reaches the outskirts of the city. Brownfields are still noticeable throughout in (very) large cities. But their growth rate is less pronounced, implying better solutions and stricter management of urban expansion, which is favoured by a stronger socioeconomic dynamic.

To summarise, four major socioeconomic factors affect the post-socialist city's spatial transformations: de-industrialisation, tertiarisation, gentrification and suburbanisation. In terms of morphological and functional patterns, this translates into a dense urban core followed by a decreasing land artificialisation trend towards the outskirts, pierced by several higher peaks along the way, primarily in the case of (very) large cities; an urban core subject to both the gentrification and tertiarisation processes; and a phenomenon of urban sprawl which, in addition to its usual main residential specialisation, is also characterised by large shopping centres or industrial parks. However, CEE urban areas remain pierced by plenty of brownfields most likely of an industrial or administrative nature – a legacy of the bankruptcy of old socialist factories – which are increasingly common towards the city's periphery. This leads to intensively artificialised urban areas where green urban spaces are primarily concentrated around the city core despite the fact that there is an undeniable need for more green spaces across the city. However, the paltry growth rate of green spaces is insufficient to fulfil the needs of the population.

In conclusion, while urban sprawl is an indisputable phenomenon across CEE, the post-socialist city is also densifying its core, while also beginning to control its urban functional diversity more strictly. Despite confronting numerous difficulties and missteps in terms of urban planning policies and strategies, gone are the days when you could build anywhere you want. The urban development process may remain somewhat chaotic, but in most contemporary post-socialist cities in CEE, there is no 'constructing everything, everywhere' anymore. It is clear that there is no single model for the post-socialist city, but rather several linked to the cities' hierarchical

position within the national/regional level, the 'catching up' of CEE cities occurring in gradients than at the same rate and intensity everywhere. (Very) large cities are developing closer to Western European cities, supported by a more dynamic socioeconomic context that has provided more urban development opportunities, allowing a faster and more coherent transition from socialist urban development planning. The medium-sized and small cities, which lack the majority of those prospects, are still struggling to overcome the communist legacy. The multiple remaining brownfields or a lack of (new)green urban areas, to name a few factors, are testimony to this. Moreover, this study has provided evidence to support a reduction of the dysfunctions and/or discontinuities of post-socialist urban areas, by identifying and quantifying what truly defines them from the morphological and functional perspectives, while emphasising that one size does not fit all CEE cities. Specific urban development policies that are sensitive to this diversity and heterogeneity are required to accommodate the morphological and functional characteristics of post-socialist cities. Finally, while not its main objective, the methodological framework employed adds to the approaches used to comprehend urban planning particularities and morphometric characteristics of cities, drawing on classical approaches while employing new advanced analysis methods such as the Geographic Information System (GIS).

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Disclosure statement

The author reports there are no competing interests to declare.

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