PATTERNS OF URBAN LAND-USE IN EASTERN EUROPE – EXPLORING GMES DATABASE USING THE LOCATION QUOTIENT

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Abstract: The location quotient shows us that in the cities from the Eastern Europe the polycentric development policies are difficult to implement, because the spatial development of the built areas, respectively green areas does not present a well-organized distribution, but a chaotic development with a tendency of concentration in the centre of the city or near it, decreasing towards the periphery. Therefore, establishing a fairly ratio between the built areas and the green areas in the cities of Eastern Europe will be relatively difficult because the totalitarian regime imposed a territorial development which did not take into account the importance of green areas within the built areas and planning them, now, in the conditions of restricted areas requires a large amount of financial resources that few countries have in this region. However, despite these difficulties, there have been several attempts of introducing the Western European strategies for the territorial development of urban areas which shows us that there is a possibility that the cities from Eastern Europe reach the same level of progress as the cities from Western Europe in what concerns the polycentric development policies.

Keywords: *location quotient, patterns, land-use, GMES Urban Atlas, green urban areas, industrial areas, residential areas, territorial planning polycentric development policies*

1. Introduction

The general trend of urbanization across Europe brings to the foreground the issue of the land-use in urban areas in order to develop plans for a systematic expansion of cities, which would meet the requirements for a sustainable development. Territorial expansion of the cities of the Eastern Europe was shaped by forces which were different from those in Western Europe, forces that have not paid attention to the requirements of the population but, to the administration and the economy. Industry was the principal factor which was taken into account when planning the development of a city, while the green areas had been neglected, which explained the large number of industrial areas and their strong growth and the relatively small number of green areas.

There are a lot of cases when the industrial and the residential areas are concentrated in the same sector, while green areas are dispersed and in most cases arranged in a compact area, relatively away from the urban core which resulted in a decreased accessibility for some of the population if we take into account the fast pace of everyday life, which is dominated by the principle of least effort.

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Totalitarian regimes that were established after World War II in the countries of the Eastern Europe represented a negative element in the territorial evolution of the cities from this region. The effects are still visible nowadays because the cities of Western Europe have a relatively well-organized spatial development while those of the Eastern Europe had a chaotic development that was the result of industrialization and also of forced territorial expansion made during the communist period, when keeping a balance between the built spaces and the green ones was not a priority.

Thereby, creating a fairly ratio between the built and green areas in the cities of Eastern Europe is relatively difficult, as most of them have territorial plans, which do not take into account the importance of green spaces within the built areas and planning them in the conditions of restricted areas requires a large amount of financial resources that few countries have in this region.

2. Methodology and database

Urban areas cause the fastest transformation of land-use, as they are in a continuous development, mainly due to population growth that induces the necessity of planning new residential/ commercial areas, etc.

The premise on which this study is conducted is the idea that territorial plans for the expansion of cities of Eastern Europe had been designed around a single pole of concentration, focusing on the expansion of residential, commercial and even industrial areas, fragmenting and even reducing the surface of the green areas within cities (natural areas - e.g. forests), because it was not taken into account the patterns of polycentric urban development, which could have solved the uncontrolled concentrations and uneven distribution in the cities for the residential/industrial/commercial areas and green urban areas.

The database required for this study was taken from the GMES Urban Atlas developed by the European Environment Agency which contains maps that analyse land use and land cover for Large Urban Zones with more than 100.000 inhabitants as defined by the Urban Audit. This study worked with the following categories:

a) Continuous Urban Fabric *(CUF)* - built-up areas with an average degree of soil sealing greater than 80%; predominant residential use, independent of their housing scheme. (single-family houses family houses or high rise dwellings, city centre or suburb).

b) Discontinuous Dense Urban Factory (DDUF) - built-up areas with an average degree of soil sealing greater than 50 - 80%; Predominant residential buildings, roads and other artificially surfaced areas;

c) Forest(natural and plantation) – areas with ground's coverage of tree canopy greater than 30% and tree height greater than 5 m;

d) Green Urban Areas (GUA) - public green areas with a predominant recreational use (e.g. gardens, zoos, parks)

e) Industrial, commercial, public, military and private units (ICPMPU) – the most of the surface is covered by artificial structures (e.g. buildings) or artificial surfaces (e.g. concrete, asphalt or otherwise stabilised surface, e.g. compacted soil, devoid of vegetation) and the land is used for industrial, commercial, public, military or private activities.

This study analysed only the five categories mentioned above because it was considered that they are the most relevant in terms of modelling future urban land-use plans, which would be in accordance with a sustainable development, and also they have the largest share in terms of land use in nowadays urban areas.

The method used in this paper to analyse the spatial concentration / dispersion of the categories mentioned above in cities of Austria, Czech Republic, Hungary and Romania was calculating the location quotient for residential areas, industrial areas and green areas (forests included).

The location quotient is the most commonly utilized in economic analysis for comparing a phenomenon in a district to an entire region. In human geography, the location quotient is used to determine the spatial distribution (clustering/dispersal) of a phenomenon on a small area, compared to a reference region. "The Location Quotient is a measure which compares the relative importance (in terms of output or employment) of an industry in a region to its relative importance in the nation (Jensen, et al., 1977)

The maps provided by GMES Urban Atlas were, therefore, processed using the software ArcGIS v.9.3 in order to obtain the necessary database to confirm or infirm the above hypothesis. In addition, after extracting the database, Microsoft Excel was used in order to calculate quicker the location quotient for each city. The next table explains step-by-step the method used in order to obtain information for all the thirty-nine cities analysed in this paper.

Table 1: The Method used in ArcGIS v.9.3

Step	Method
1	Open ARCGIS v.9.3 => Open the map of the city which will be analysed
2	Select the map => right-click => Open Attributes Table => Options => Select by attributes
3	Create a new selection => double-click on ITEM => Get unique Values => ITEM = Continuous Urban Fabric (CUF) /Discontinuous Dense Urban Fabric (DDUF) /Industrial, commercial, public, military and private units (ICPMPU)/Green Urban Areas (GUA) /Forest => Apply
4	Right-click again on the map => Data => Export Data
5	Save the new data => Export the data as a new layer
6	Select all the layers created for the five categories => Start Model Builder => Drag &Drop the selected files => Spatial Statistics Tools => Utilities => Drag & Drop Calculate Areas for every layer => Add connection for each layer => Run
7	Select the initial map of the analysed city => Spatial Statistics Tools => Measuring Geographic Distribution => double-click Mean Centre => Input Feature Class => add the layer with initial map of the analysed city => Ok
8	Bring the new layer in ARCGIS => Analysis Tools => Proximity => Multiple Ring Buffer => Input Feature Class => select the layer which was created in the previous step => distances (introduce the distances at which the ring-buffers will be created for example from 500 to 500 m, taking into account the total area of the analysed city) => Ok
9	Start Model Builder => Drag & Drop the layers created in the sixth step => Drag & Drop the layer with the multiple ring-buffer for all the layers that were brought to model builder => Analysis Tools => Overlay => Drag & Drop Intersect for all the layers which were created on the sixth step => add connection for CUF/DDUF/Forest/GUA/ICMPU + the layer with the multiple ring buffer => Run (see Figure 1)
10	Right-click on the new created layer (CUF/DDUF/Forest/GUA/ICMPU) => Open Attribute Table => Options => Add field…(type=Float) => select the new field => Calculate Geometry => Ok (see Figure 2)

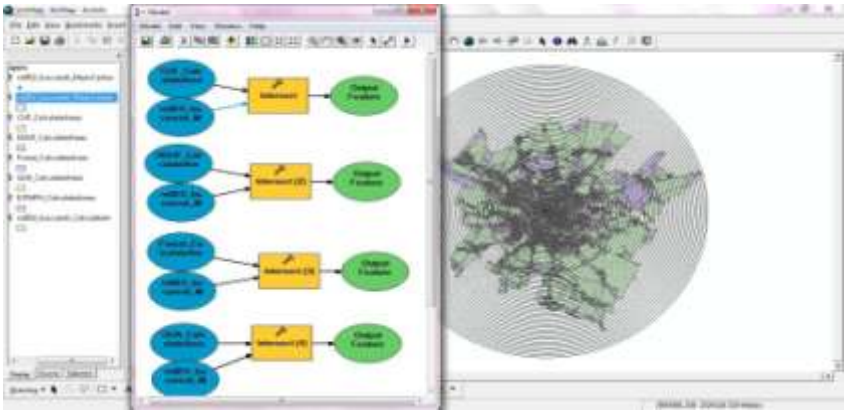

Figure 1: Sample of Model Builder for Step 9 – ArcGIS v.9.3 (city: Bucharest)

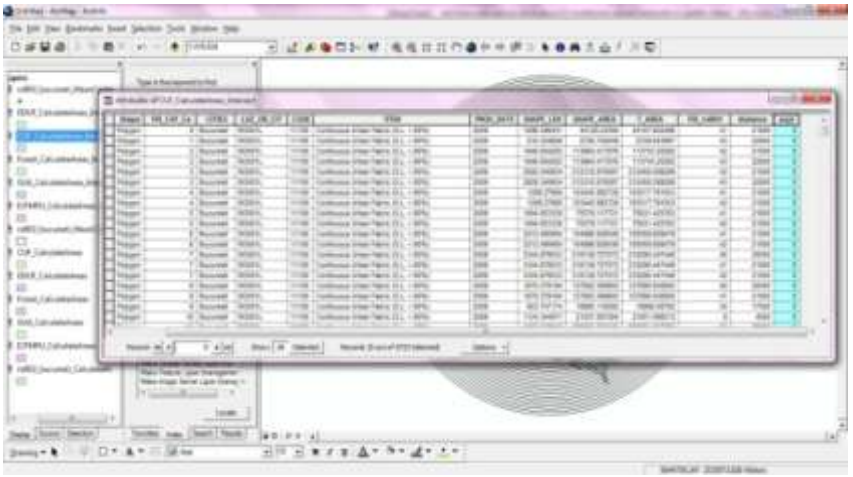

Figure 2: The final results for CUF - ArcGIS v.9.3 – step 10 (city: Bucharest)

The next phase of the paper consisted in calculating the location quotient for each of the five categories analysed for all the thirty-nine cities. In order to get the necessary results for designing urban patterns of territorial expansion for the cities, the Microsoft Excel software was used in order to obtain faster results in a shorter time.

3. Patterns of land-use in Eastern Europe

3.1. Austria

From the four countries analysed, Austria is the only one that presents a territorial planning of the cities that allows the implementation of the sustainable development policies without too many problems because the territorial expansion plans of the cities followed to integrate the green urban areas into the residential ones and even into the commercial and industrial ones. Therefore, values above one were obtained for the location quotient for the residential areas and green urban areas until the ring-buffer of 5,500 m created around the mean centre of Graz, while the values for Wien (see Fig. 3) stopped at the ring-buffer of 9,000 m. Linz had values above one until the ring-buffer of 12,000 m for the residential areas, while the green urban areas do not have a location quotient greater than one. However, it should be noted that here the location quotient for industrial areas had only one value above one and the

rest are lower. The location quotients for the industrial areas from Graz and Wien (see Fig. 3) that are above one are located in the same areas with the residential and green urban spaces.

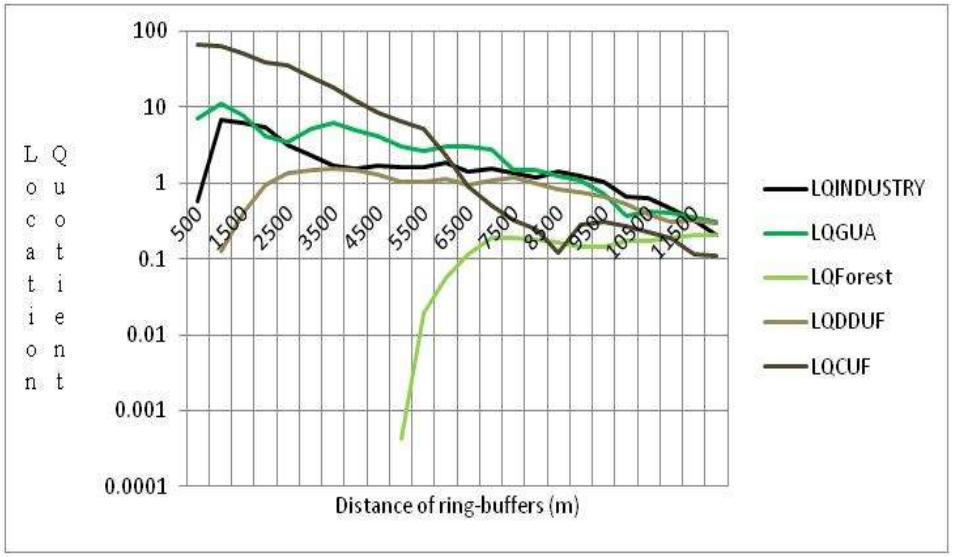

Figure 3: The values of Location Quotients for Wien (logarithmic scale)

3.2. Czech Republic

The patterns of land-use in Czech Republic kept the structure of the expansion planning from the communist period which focused on the development of the industry and the residential areas. Cities like Ceske Budejovice, Hradec-Karlove, Liberec, and Usti nad Labem had values bigger than one for the residential and industrial areas on a greater area than the green urban areas do. Thus, the green urban areas had a spatial concentration starting from the ring-buffer of 1500 m until the one of 6000 m made around the mean centre of the cities and after that the values went down below 0,5. The residential and industrial areas had values greater than one until the ring-buffer of 7000 m. Thus, this concentration meant fewer areas for planning parks and other recreational spaces.

There are also cities that showed a fragmentation in the spatial distribution of the values of the location quotient, which indicates a chaotic territorial planning and a poor valorisation of space. Brno, Jihlava, Karlovy Vary, Olomouc had this pattern of urban land-use. The green urban areas did not exist within 1000 m radius around the mean centre of the cities, but there are also no residential areas concentrated in this perimeter. The green urban areas are concentrated at a large distance from the mean centre of the cities, starting from the ring-buffers of 5000/5500 m. However, within the values higher than one, there were interfering one or more values of the location quotients below one, which indicated an expansion of the residential/commercial/industrial areas to the detriment of green urban areas. It should be noted that Zlin had the majority of the values of the location quotient below one with a single exception that is above one for each category.

Miskolc, Plzen and Prague were the only cities from the ones analysed of the Czech Republic whose expansion plans did not appear to have been guided only by the economic efficiency, but also by the protection of the environment. Thereby, the values of the location quotient which were above one were concentrated in the same area (until the ring-buffer of 7000 m) and in the case of the capital, the values greater than one continued up until the ring-

buffer of 10000 m (see Fig. 4), which represents a plus for Prague in what concerns of implementing the sustainable development policies.

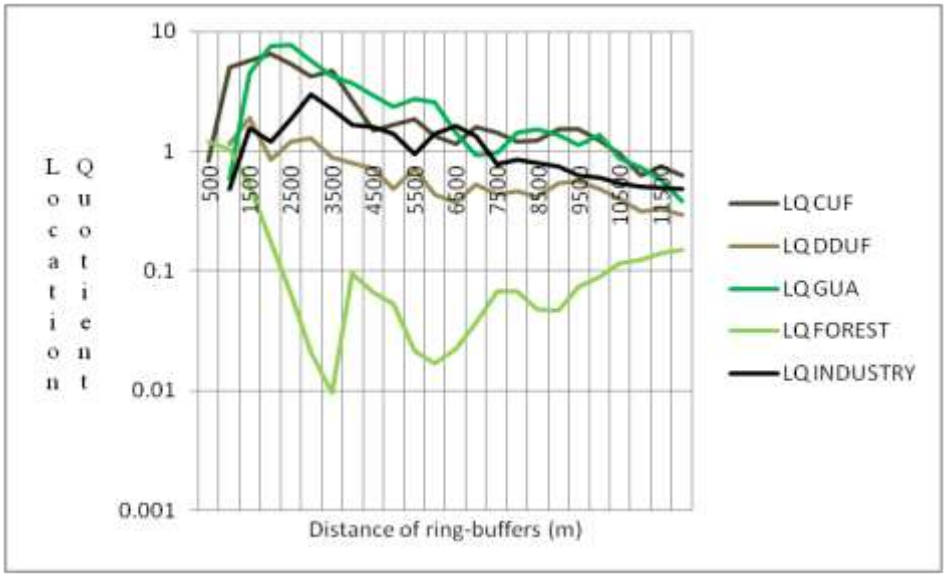

Figure 4: The values of Location Quotients for Prague (logarithmic scale)

3.3. Hungary

Hungary, like Czech Republic was also under the influence of the Soviet regime after the end of the Second World War and so the plans for territorial development had the same manner of spatial distribution of the values of the location quotient as the Czech Republic.

Kecskemet and Szekesfehervar had a location quotient above one for the industrial and residential areas that exceeded the radius of distribution for green urban areas. Thus, while urban green spaces extended over 4500/5000 m radius around the mean centre of the two cities, the residential and industrial areas were concentrated within a 6000 m radius.

Nonetheless, it should be noted that Hungary had a lot of cities, which had spatial disparities in what concerned the distribution of the values of the location quotient bigger than one of the analysed areas. Debrecen, Gyor, Ostrava, Paradubice and Pecs fitted in this category because the expansion plans of the cities were not made in a systematic manner, and therefore, it resulted in a chaotic organization that did not maximize the use of the land. However, these spatial disparities may be an advantage for the future plans for territorial spreading of the cities, as they allow the integration of green urban areas into the residential or industrial areas, and it could also be a starting point for a territorial planning based on polycentric patterns favouring territorial cohesion.

Nyiregyhaza, Szeged and Budapest had a distribution of the values of the location quotient above one for the green urban areas which exceeded the radius within the residential and industrial areas concentrated. Budapest stood out because the green urban areas had values above one for the location quotient within an 11000 m radius from the mean centre of the city while the residential and industrial areas location quotients fell below one starting from the ring-buffer of 6500 m. Therefore, we see here a constant concern for territorial development according to the sustainable development policies.

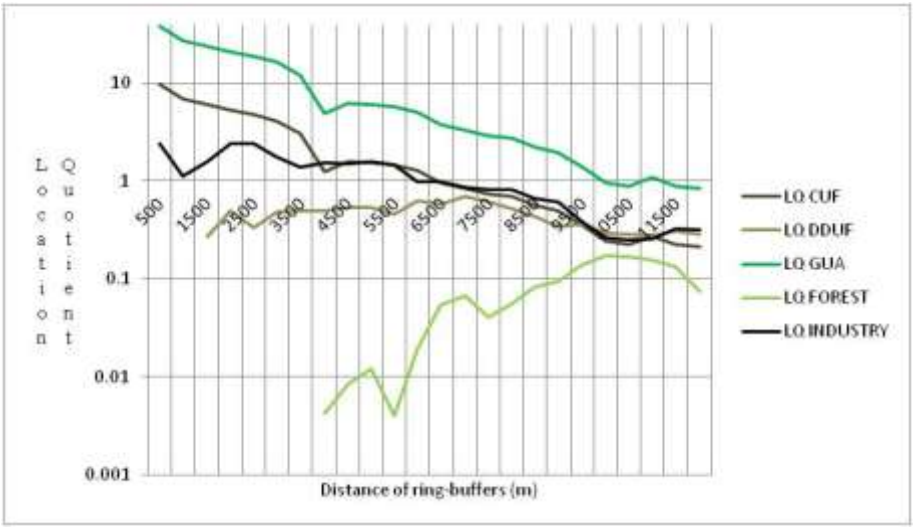

Figure 5: The values of Location Quotients for Budapest (logarithmic scale)

3.4. Romania

Coming under Soviet control after the Yalta Conference, Romania built on its territory new cities with a single function – the industrial one. This is why, the development plans of the majority of the cities did not include green urban spaces inside the central core of the cities, and also the residential areas are situated close to the industrial ones. Cities like Brailia, Calarasi and Giurgiu whose industrial function was induced also by the fact they are ports at the Danube and also, Arad, Bacau, Oradea, Craiova whose predominant function was the industrial one had plans for an urban development that did not focus on expanding the green urban areas, but on developing new areas for increasing the industrial activity. This explains why urban green spaces are concentrated within a 3000 m radius from the mean centre of the cities, while the residential and industrial areas had values that extended to a 4500 m/5000 m radius.

However, there are cities whose spatial distribution of the values of the location quotient may indicate the existence of a relatively well-planned urban development which followed to integrate the sustainable development policies. This statement applied to Alba - Iulia, Cluj - Napoca, Piatra Neamt, Sibiu, Targu Mures and Timisoara, which had a spatial correlation of the values of the location quotient that were greater than one for the residential, industrial and urban green areas, all of them concentrating in the same area (within a 4000/4500m radius, with a maximum extension of 6500 m for Sibiu). This showed a good ratio between the built and the green urban areas which could be suitable for a sustainable development.

Bucharest (see Figure 6), on the other hand, had spatial disparities in the distribution of the values greater than one for the location quotient, especially for the green urban areas which oscillated from a high degree of concentration to a dispersed one. Residential and industrial areas had a greater expansion in the perimeter of the city with a higher degree of concentration than the urban green areas. This is a negative factor for Bucharest, in contrast to Prague and Vienna, which focused on expanding the green urban areas, while here the expansion plans have not considered the importance of creating green areas into the residential and industrial ones. Therefore, Bucharest did not seem to be on the right track in terms of sustainable development.

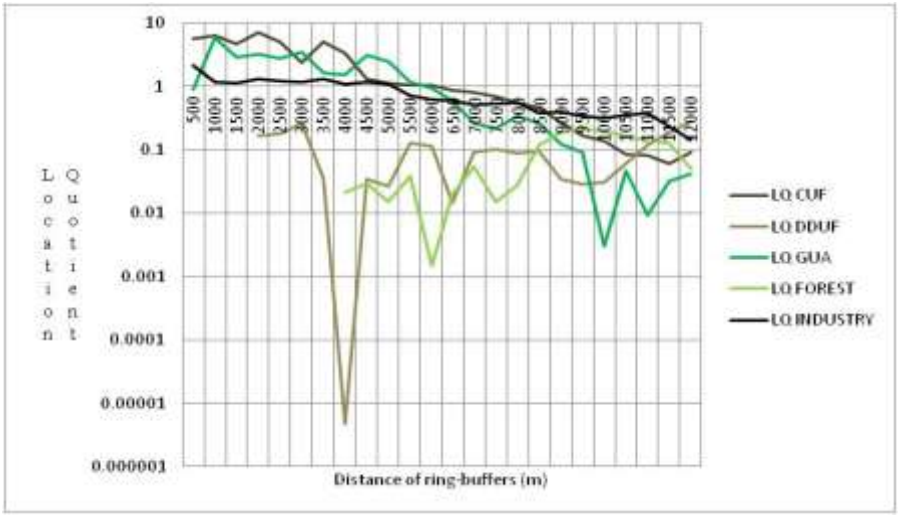

Figure 6: The values of Location Quotients for Bucharest (logarithmic scale)

Furthermore, the common element for the vast majority of cities analysed was the value of the location quotient for the forests. The values above one were found only in two cities from Hungary (Nyregyaza and Gyor), four cities from the Czech Republic (Brno, Hradec - Kralove, Liberec and Zlen) and one city from Romania (Sibiu). Moreover, this category was not found around the central core of the cities, and it was usually localized to the extremities of the urban areas, which, on the one hand, it made sense since the territorial development of the cities required new spaces to build residential and commercial areas, but on the other hand, it had negative effects for the environment because of the massive deforestations that were made. The exception is Austria, which was not influenced by a totalitarian regime and also by a planned economy, which would have imposed the construction of new cities based on industrial activities. Therefore, Austria could organize the urban space in a manner that could provide favourable conditions in terms of economic and administrative development without reducing the green urban areas which would have had negative effects for the health of the population.

To sum up, the four countries have patterns of land-use in urban areas that are confirming the hypothesis of this paper because the territorial development of the cities did not have any particular spatial order nor did they show any interest in improving the urban environment by building new green urban areas among the built spaces. Nevertheless, they still seemed to focus on building new residential areas, even industrial ones, which indicated that there were still echoes of the totalitarian regime that influenced their development.

4. Conclusions

Urban areas of the Eastern Europe have experienced a complex evolution due to the changes that have occurred in the administrative, economic and social domains, especially in the last twenty years. Therefore, the use of lands in the analysed area had gone through a lot of changes, especially by converting agricultural and forest land (where available) in residential and commercial spaces. However, these changes did not follow a systematic plan of territorial development, which had led to a territorial planning that made difficult the introduction of the polycentric urban patterns which are now promoted for a better territorial cohesion.

It should also be noted that in the large cities of Eastern Europe, the organized strategies for territorial development are difficult to implement because the spatial distribution of the built areas and the green urban areas did not show any systematic order because they tend to concentrate around the initial core of development of the city or in its immediate proximity and after that they tend to decrease continuously until the periphery. The territorial fragmentation of urban areas is well evidenced by the location quotient, which proved to be a viable tool to highlight the spatial disparities in the urban space.

As former communist countries, except Austria, they tend to encounter some difficulties when implementing the new strategies for territorial cohesion promoted by the European Union. Based on a planned economy more than 50 years, the territorial expansion of the analysed cities in the Czech Republic, Hungary and Romania did only concentrate on the construction of new facilities for the development of industrial activities, which were necessary for the economic progress in accordance with the communist ideology. However, now when we are witnessing at a compression of the industrial activities because a sustainable development is promoted, these countries are forced to close the great majority of the industrial units as they go against the rules which are protecting the environment. Moreover, since these countries lack the financial means necessary for an urban re-planning of the industrial areas ,which would be in concordance with the sustainable development, the industrial areas are often abandoned, which is a negative factor regarding the territorial expansion of the cities, as these surfaces determined the spatial discontinuities in the territorial planning, discontinuities that did not allow the correct implementation of the policies for a better territorial cohesion.

Although after the 1990s we began to have constant concerns for the protection and conservation of the green areas, they are not enough because of the fact that the number of inhabitants in the cities is in a constantly increasing and the surface of green space per inhabitant is becoming smaller. However, this decrease is not explained only by the fact that the artificial spaces have been developed at the expense of green spaces, but it can also be explained by the increase of the density of the population, even though there are situations when large natural areas, for example, large areas of forests were cleared for territorial expansion of a city.

It was also noted that with the territorial development of a city, the accessibility of population to green urban areas decreased since the focus is on building new residential, commercial or industrial areas and not on planning new public gardens and parks. In this way, the only green areas accessible to the residents remained forests, which find themselves on a steady decline, too. Thereby, creating a fairly ratio between the built and green areas in the cities of Eastern Europe is relatively difficult, as most of them have territorial plans, which did not take into account the importance of green spaces within the built areas and planning them in the conditions of restricted areas requires large financial resources that few countries have in this region.

One solution for the spatial and territorial reconfiguration of these cities which would make the transition from an exclusive concentration of the residential and green urban areas in the central part of the cities to a pattern based on a polycentric development would be, firstly, controlling the suburban areas, which tend to develop chaotic, generating an amorphous urban network, which generally leads to an environmental degradation. Nevertheless, the initial core of the cities should be revitalized through measures directed against the trend to abandon the industrial spaces, seeking in this way an urban regeneration, which is necessary for encouraging the economic development of these countries in order to reach the level of territorial cohesion of Western Europe.

Finally, taking everything into account, the premise of this paper is confirmed because the territorial development of the cities of Eastern Europe had been designed around a single polarization core, as demonstrated by the concentration of the values of the location quotient above one around the centre of the cities analysed. Moreover, the decreasing of the values of the location quotient for the urban green areas starting from the mean centre of the cities to the suburban areas and the very low values of the location quotient for the forests stressed out that territorial development had focused and is still focusing on building new residential, commercial and sometimes even industrial areas, fragmenting the green urban areas and even reducing their surface (natural areas – e.g. forests). Therefore, the urban planning for the expansion of the cities should focus on introducing the urban polycentric patterns which could lead to the disappearance of the spatial disparities created by the single-core pattern, which promoted a high density commercial core surrounded by residential suburbs without introducing green urban areas among them.

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