Urban transitions and resilience of Eastern European Union cities

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Abstract

Urban resilience is related to the capacity of cities to recover from disruptions, to maintain their functions and thrive after a sudden shock or a long-term stress, from economic crisis, from natural and technological disasters or climate change. The present study refers to former communist countries in Eastern Europe which are now integrated in the European Union (including Greece, by reasons of spatial coherence), namely the cities and agglomerations that have more than 500,000 inhabitants. The analysis focuses on the post-communist transitions of these cities reflected in certain socio-demographic, morphological and functional urban transformations, highlighted by indicators obtained by integrating data from different evaluations already carried out at the EU level. The results of multi-criterial statistical analysis reveal the identity of the analysed urban areas and the diffusion processes in resilience approaches from Western EU to Eastern countries and cities by adaptation practices implemented at different rhythms and to different degrees.

Keywords: urban transition, post-communist city, resilience capacity, multi-criteria analysis, clusters

Introduction

General framework

Cities are extremely complex systems, hubs of development and engines of regional growth, concentrating population, economic activities and infrastructure, often subject to diverse perturbations that sometimes might transform into disasters (De Sherbinin, 2007). Moreover, urban development itself is not a smooth process towards a state of balance, but rather a passage from one imbalance to another. These

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processes are associated with demographic transition and the transition of population mobility, carried out in stages that partially overlap with their phases and which are illustrated by urban dynamics, a function of the level of social economic development materialized through the manifestation of the urban hierarchy. Therefore demographic transition is essential for understanding the urbanization process (Steck, 2006).

In a first stage, urbanization is a punctual process, closely related to the need for exchange, defence or spiritual role, with a balance between urban growth and rural population growth. Exceeded for a long time, this stage was followed by the manifestation of massive population flows from the rural areas to the existing cities, a process in which urbanization also manifests certain territoriality by transforming both local polarising centres and polarised areas, modified, in trier turn, by the industrialization. This fact is imposed by the exploitation of resources or by positional advantages.

This stage, also overcome in developed and, partially, in the emerging countries, is followed by a period when the process is close to the maximum, with the manifestation of contradictory phenomena such as peri-urbanization, metropolitan areas formation or counter-urbanization, all against the background of the end of demographic transition and the increasing human mobility (Latham *et al.*, 2009). Taking the form of extensive urbanization (the diffuse city, the city-territory or the city-network), the urban transition is currently based on the theory of self-organization or synergy, supported by new models of territorial dynamics (Cosinschi and Racine, 1998).

The political response of these new developments, combining urban systems and land use, social ecology and urbanism principles, overlapped on the ambiguous relationship between the built space and the rapidly changing environment, should only be that of conscious planning in the spirit of sustainable urban development.

Meanwhile, there is an increasing uncertainty due to climate change, migration of population, and changes in the capacity of ecosystems to adapt to these modifications and generate goods and services (Ernstson *et al.*, 2010). Relying on a predictable future is therefore inefficient and maybe destructive, since demographic and spatial urban transition has to be followed by transitions in urban planning, development and management practices (Ernstson *et al.*, 2010, Tyler *et al.* 2016) in order to make cities more resilient.

In general, urban resilience is the ability of individuals, communities, institutions, economic activities and infrastructure within the city to survive, adapt and grow despite chronic stress, which weakens urban fabric every day (unemployment, inefficient public transport, violence, chronic food or water shortages, etc.) or acute shocks (earthquakes, flood epidemics, terrorist attacks, etc.)[1]. A resilient city is more capable of anticipating, preparing for and absorbing

[1] Read more about '100 Resilient cities' (http://www.100resilientcities.org).

shocks, while maintaining or rapidly returning to the same basic structure and ways of functioning by using the capacity of self-organization and adaptation to stress and change (Walker and Salt, 2006). In this regard, one can delineate two different types of cities and metropolitan territories: *static* - that resist by either adapting or reinventing themselves and *dynamic* - which see the opportunities that 'shocks' can offer by participating in the implementation of some innovations (Hamdouch, 2014).

Both approaches relate to designing local and regional strategies and measures for strengthening infrastructure and ecosystems in order to reduce their fragility, increasing social and administrative capacities to anticipate and develop adaptive responses, and to access and maintain supportive urban systems by creating institutional premises for an effective response to the actual and future vulnerabilities (Tyler and Moench, 2012; Tyler *et al.*, 2016).

Meanwhile, resilience represents a new way of thinking about sustainability. It is not mainly a normative concept, but rather a strategic one, based on - and informed by - the environmental, ecological, social, and economic drivers and dynamics of a particular place, and it must be integrated across a range of interlinked scales (Pickett *et al.*, 2004; Ahern, 2011). Therefore, in a broad sense, the principles of resilience seem to overlap with the overall 'natural' development of urban areas, as cities have social and economic capacities to rebuild (Vale and Campanella, 2005; Campanella, 2006). In this regard, urban resilience is considered to be "a general quality of the city's social, economic, and natural systems to be sufficiently future-proof" (Thornbush *et al*., 2013, p. 2).

Urban resilience can be discussed in an integrated manner in the context of risk and vulnerability assessments, institutional and social governance structures, or it can be analysed according to different sectors (urban ecosystem resilience, city economic resilience, etc.) by following the path of the urban areas specific transformations (Chelleri and Olazabal, 2013). In some more limited approaches, urban resilience is exclusively the ability of cities to function, so that people living and working in that city - especially the poor and vulnerable - survive (IIED, 2009).

There are numerous approaches in defining urban resilience capacity and performance by doing surveys on the resistivity and adaptability of the two systems that are intrinsic parts of cities: ecosystems and social-economic (sub)systems (Gibberd, 2014), in terms of social, infrastructural, economic and institutional resilience (World Bank, 2012), or by integrating a large number of variables in indexes. Some relevant examples are: *Resilience Capacity Index* for US metropolitan areas resulted from 12 indicators in three categories – regional economic, socio-demographic and community connectivity capacity (Foster, 2011), *Sustainable City Index*, a composed indicator that evaluates municipal policies and activities that promote sustainable and resilient practices in Israel cities (Crabtree, 2012), *Urban Resilience Index*, a multi-hazards integrated approach taking into account the capacity to withstand and recover quickly from catastrophic events (UN-HABITAT, 2012), *The Better Cities Index* (BCI) based on their urban environmental

sustainability, the authenticity of the local governance, and their socioeconomic conditions (Lakshmisha and Agarwal, 2016) etc.

To sum up, in order to measure urban resilience one can either assess the cities' *performance* in responding past disastrous events or threats *or their general capacity* not focused on a certain disaster, but on the ability to resist shocks as "some (…) [units] are structurally more prepared than others, and have greater capacity to bounce back in the wake of a stress" (Foster, 2011). The present paper mainly focuses on the resilience capacity of the large cities and urban agglomerations from the countries in the Eastern part of European Union.

1. The context of Eastern European Union cities

In Central Eastern Europe, the urban transition was strongly marked by the particular way in which the urban phenomenon was imposed in this part of the continent. In this case, urbanization is very discontinuous and more or less delayed (Bairoch, 1976), except for the case of the Balkan Peninsula areas, influenced by exogenous processes, initially imposed by successive diffusion from the Mediterranean, and later, much deeper and more sustainable, from Western Europe. The often allogeneous nature of the cities in the region, long standing in opposition to the surrounding rural areas (not only from the viewpoint of the ethnic and confessional structures), was worsened by high economic disparities, that created steep socio-spatial discontinuities (Chirot, 2004).

The quasi-absence of far-reaching political and economic centres has led to a dependence of Central Eastern European urban systems on the main Western centres (including cities in the immediate vicinity such as Berlin or Vienna). At the level of political command, the dependence on the major eastern cities (Moscow and St. Petersburg, and even Istanbul) did not become effective from an economic or cultural perspective, rather it was an undesirable subordination sustained with the hope for a later independence.

Given these characteristics, cyclical processes recurrent to urban transition also occur, "more cyclical" than in Western or Southern Europe, often fragmented by the rivalries of Western, Eastern or South-Eastern powers.

The experience of the two World Wars and especially the traumatic episode of the imposition of the communist regimes had destructive and differentiated effects on Central-Eastern Europe's urban system. Although they shared, more or less, the same history during this period, each country took its own path of development. Central Europe was more resilient by showing resistant and sustainable structures imposed by long-lasting contacts with the West. More hesitant, Eastern and South-Eastern Europe confronted a certain destruction of its fragile urban fundamentals which has caused traumas that are still far from being solved (Lévy, 1998).

A particular case is the urban systems consisting mainly of Balkan cities that have long gravitated around Istanbul, where a complete functional restructuring had

initially been done. This incomplete adjustment with the dynamic model of Western-European urban systems (both from an architectural and an administrative perspective, regarding, for example, governance practices) produced a West-East gradient, noticeable in all details of urban life in the region, especially when taking into account social polarization and segregation (Kovács, 2014).

In the last 27 years, post-communist cities suffered profound, but divergent, transformations that marked a change of paradigm in the urban development. It is reflected by a population trend that is a rather "original" combination of extremely low birth rates, migration losses and moderate mortality leading to rapid population ageing together with population decline in many countries of the region (Lutz, 2010). Meanwhile, land-use instability of these urban systems has practically limited the attempts at sustainable management, disfavouring peripheral urban centres and delaying the coagulation of metropolitan areas (perhaps with the exception of capital cities). Facing a certain delay in comparison to Western cities from the perspective of contemporary urban dynamics, the Central Eastern European city is forced to miss out stages and phases of evolution in order to correspond to standards that have been laid down by various official documents. For example, convincing forms of urban mobility, which could be compatible with the need to respond to the challenges induced by excessive consumption of energy and subsequent contribution to global climate change, are still far from being implemented. The creation of a sustainable transport system is seen as a prerequisite hope for a resilient city in the region by many authors (Newmann *et al.*, 2009, Gössling, 2013).

The absence or limitation of large-scale works (hydro-technical, infrastructure) reduces the polarization capacity of many cities in the region, partially blocking their development potential. A ray of hope can be found though, i.e, the faster accommodation from the perspective of new forms of communication (air transport, telecommunications) that can be seen as a form of crossing stages of urban transition and a chance to connect to more functional circuits in terms of social and economic outcomes.

There are hopes for the evolution of sustainable urban development based on efficient management compatible with the local potential of urban territory (Havel, 2014). If the Western city is already on the path of transition to a sustainable urbanized, geostrategic equilibrium (Ernst *et al.*, 2016), the Eastern European Union city has to deal primarily with the issue of governance, still marked by inefficiency. One can assess in the case of Eastern European Union cities not just the "good resilience" i.e. preparedness, responsiveness and adaptation to the new regional and global challenges, but also forms of the "bad resilience" i.e. resistance to change by inheriting and propagating obsolete, inefficient and harmful structures and practices (Rufat, 2012).

The urban structures inherited from the totalitarian period are not totally incompatible with contemporary requirements. On the contrary, the transition from centrally-managed state-owned socialist economy to the market economy has

probably produced deficiencies that are more and more difficult to regulate. After a long, almost exclusively, demographic and economic urbanization, the Eastern European city has an intrinsic need for socio-cultural urbanization in the spirit of the ideas proposed by J. Friedmann (2002).

Therefore, it is necessary to extend a way of life and a pattern of urban living standard, both in the city itself and in its polarization area, a process underway in some of the capital cities, but still inadequate or incomplete in Central-Eastern European urban systems as a whole.

2. Methodology

The present paper is a preliminary, holistic assessment of the resilience capacity and (to a lesser extent) performance by using different available indicators in order to outline a certain typology of cities and agglomerations of more than 500,000 inhabitants. The authors have taken into account 36 urban metropolitan areas and agglomerations from 12 countries (Bulgaria, Czech Republic, Croatia, Estonia, Greece, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia and Hungary). The indicators were obtained by using data from different evaluations already made at the European Union and Global scale (EEAa, 2016; EC and UN Habitat, 2016; Eurostat, 2016), but also by integrating information extracted by the authors from the cities' strategies and planning acts and from projects that were already finalised at the European level (for. e.g. ESPON projects such as GEOSPECS, 2012).

There are three types of indicators of resilience that were taken into account: demographic, social-economic and spatial-environmental. Each indicator is relevant from a certain viewpoint as mark of attractivenessy, adaptability, connectivity, diversity, efficiency and redundancy, or when creating fragmentation, inefficiency, insufficiency or discordance that induce vulnerability (Drobniak, 2014). It is important to notice that the same indicator can produce both resilience and vulnerabilities (for example, a high density of population is a sign of attractiveness of the urban area, but can also create social, economic and environmental issues).

The data were aggregated mainly at the city and metropolitan levels. In some cases, when the metropolitan areas did not officially exist, theoretical metropolitan areas established by socio-economic relations were taken into account (commuting, daily services, ex-urban activities of the city) (Bănică and Muntele, 2013).

The *demographic resilience* reflects the capacity of cities and metropolitan areas to be attractive, to retain population and to maintain a positive natural growth. Density is a valuable indicator showing the concentration of population. The age structure is an important component that describes the (lack of) vitality of population and gives an insight on its future evolution (see Table 1). The *social - economic resilience* comprises two economic indicators - GDP per employed population and the availability of jobs-, but also two social indicators population graduating university studies and the number of beds in hospitals (see Table 2).

Table 1. Demographic resilience indicators

Indicator/ ACRONIM	Period	Spatial level	Aggregation	Inducing resilience (+) / vulnerability (-)	Source
Population number change/ POP_CH	2001-2011	CITY, METROPOLITAN	The growth ratio of population between 2001 and 2011	+/-	Eurostat
Density of population/ DENS_POP	2015	CITY, METROPOLITAN	Report between total population and the area of the administrative unit	+/-	Eurostat
Young population (children)/YOUNG_POP	2007-2013	CITY	Report between no. of population 0-14 years old and total population	+/-	Eurostat
Aged population/ AGED_POP	2007-2013	CITY	Report between no. of population >65 years old and total population	-	Eurostat

Source: own representation

Table 2. Social-economic resilience indicators

Indicator/ ACRONIM	Period	Spatial level	Aggregation	Inducing resilience(+)/ vulnerability (-)	Source
Tertiary education percent/ TERT_EDU	2007-2013	CITY	Percent of people attending tertiary education among population aged 25–54	+	Eurostat
Beds in hospitals/ HOSP_BEDS	2015	REGION	The report between the number of beds in hospitals per 100000 inhabitants	+	Eurostat Regional Yearbook 2016, Eurostat
GDP growth per head/ GDP_PERS	2007-2009	COUNTY	Gross domestic product (GDP) at current market prices at NUTS 3 level reported to total population	+	Eurostat
Jobs availability ratio /WORK_POP	2006, 2009	METROPOLITAN AREA, REGION	Report between the number of workplaces and total population	+	EEA, 2016a

Source: own representation

Spatial-environmental resilience includes the (absence/lower) territorial dispersion by urban sprawl, percent of non-artificial areas, but also access to green infrastructure and good air quality (see Table 3).

Table 3. Spatial-environmental resilience indicators

Indicator	Period	Spatial level	Aggregation	Inducing resilience (+)/ Vulnerability (-)	Source
Dispersion of the built-up areas/ DIS	2006, 2009	METROPOLITAN AREA, REGION	UPU* per m2 of built-up area low < 42.5 UPU/m2 high >45.5 UPU/m2	-/+	EEA, 2016a
Air quality index/ AQ_INDEX	2006, 2011	CITY	% MAL (maximum allowed limit) for PM_{10}, $PM_{2.5}$ and NO_2 concentrations. The minimum value of the three indicators is taken into account	+	Eurostat; State of European cities, 2016
Green Infrastructure/ GREEN_INF	2006, 2010	CITY, METROPOLITAN	% of total land area	+	Eurostat; GEOSPECS State of European cities, 2016
Percent of artificial surfaces from total area/ %ARTIF	2006, 2012	CITY, METROPOLITAN AREA	Extracted from ortophotoplans by CORINE LAND COVER PROGRAMME	-/+	GEOSPECS CORINE LAND COVER

* UPU - Urban permeation units - is a measure of the permeation of a landscape by built-up areas (EEA, 2016a)
Source: own representation

The indicators were included in a multi-criterial assessment using cluster analysis in order to highlight certain categories of cities according to their phase in the urban transition process and to their relative resilience capacity. First, the data were normalised and standardised by using Z scores. Secondly, a Principal Component Analysis (PCA) was applied for exploring the connection between indicators. Finally, Agglomerative Hierarchical Clustering (AHC) was used in order to differentiate between certain categories of cities and metropolitan areas in relation to their resilience capacity and recent dynamics or trend that reflects a certain phase in the transition process. The purpose was not to find an overall resilience index of resilience capacity that could be used to rank the cities, but rather to identify clusters of large urban areas with dissimilar features and paths that create particular needs in

relation to planning a sustainable and resilient development. The statistical analyses were made in XLStat 2016 trial version while the cartography was done by using MAGRIT – a cartography open source software made by UMS RIATE (*Le Réseau Interdisciplinaire pour l'Aménagement et la cohésion des Territoires de l'Europe et de ses voisinages*), Denis Diderot University, Paris, France.

3. Results

3.1. Resilience indicators at city, metropolitan and national level

The first stage of the current assessment takes into consideration the differentiation between the analysed cities and metropolitan areas when it comes to each of the 12 indicators taken into account.

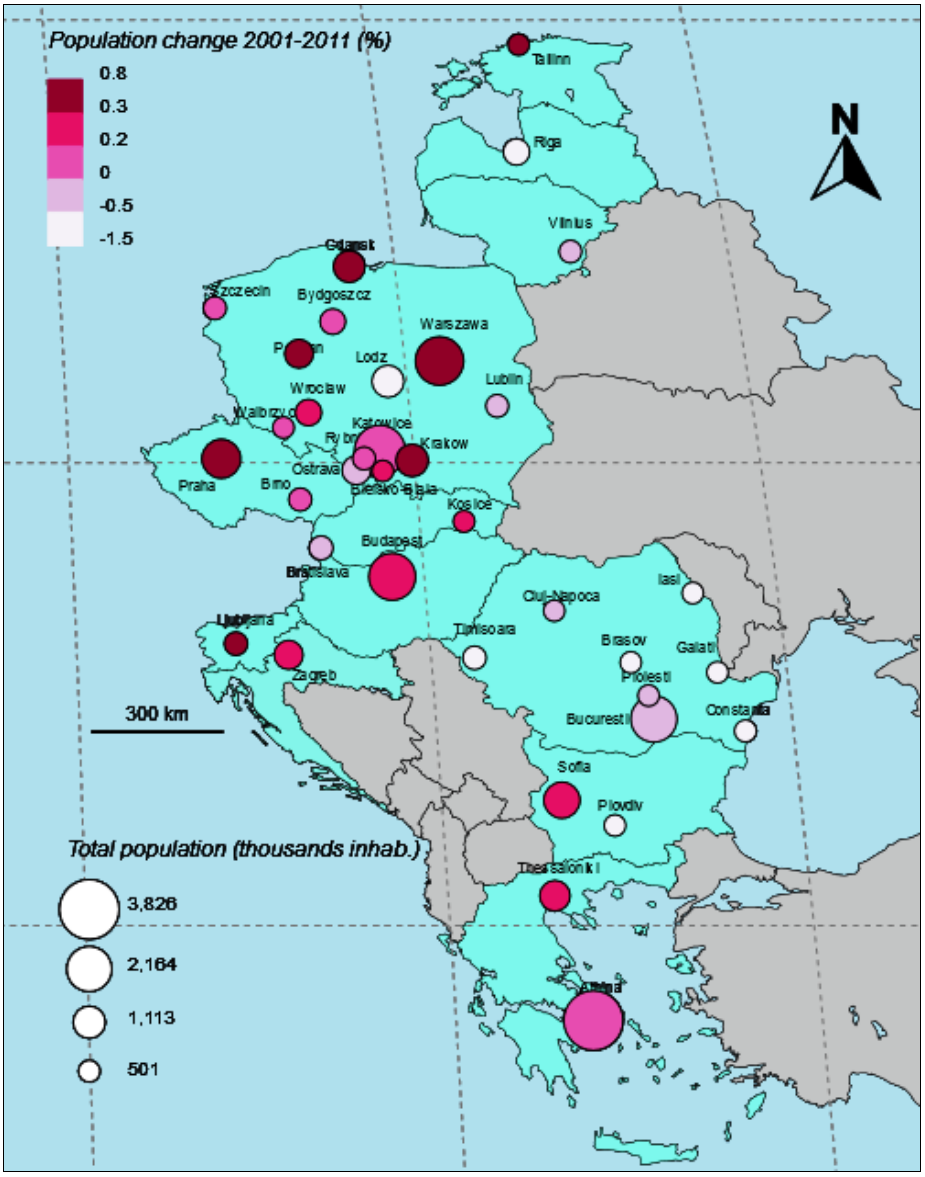
Demographic resilience

The *population change* is a primary indicator of the attractiveness of the cities and metropolitan areas reflecting the migratory balance, but also the social vitality (i.e. the natural balance). If one takes into consideration the data at the city level - the lowest values of the general population balance between 2001-2011 are typical for Thessaloniki and Riga, but also for the capital of Slovakia and in the majority of cities in Romania (with the notable exception of Bucharest and Cluj-Napoca).

In most of these, the demographic decline is typical for the core of agglomeration, but there are cases where it is found in the metropolitan area (Thessaloniki, Bratislava, Budapest, Poznan or even Athens). Among the cities and metropolitan areas that can be attractive, one can highlight some of the capitals such as Ljubljana, Prague, Sofia or Warsaw, as well as some Polish cities – for example Rybnik, Szczecin, Krakow – and also Kosice in Slovakia. A particular case is that of Plovdiv where there is a decrease in the population in the metropolitan area but an increase in the city itself (see Figure 1).

High *densities of the population* in the inner area of the city itself occur especially in the two largest Greek cities (Athens, Thessaloniki), but also in some cities in Romania (Bucharest, Ploiești and Iași), Slovakia (Kosice), Bulgaria (Plovdiv) and the capital city of Poland, all having small built-up and administrative areas.

Figure 1. Population change in metropolitan areas of Eastern European Union countries between 2001 and 2011



Source*:* EUROSTAT, made with MAGRIT

With regard to the metropolitan area, high densities characterize metropolitan areas such as Athens, Budapest or Warsaw, where the suburban and peri-urban agglomeration process was earlier. Similar situations are also specific to smaller

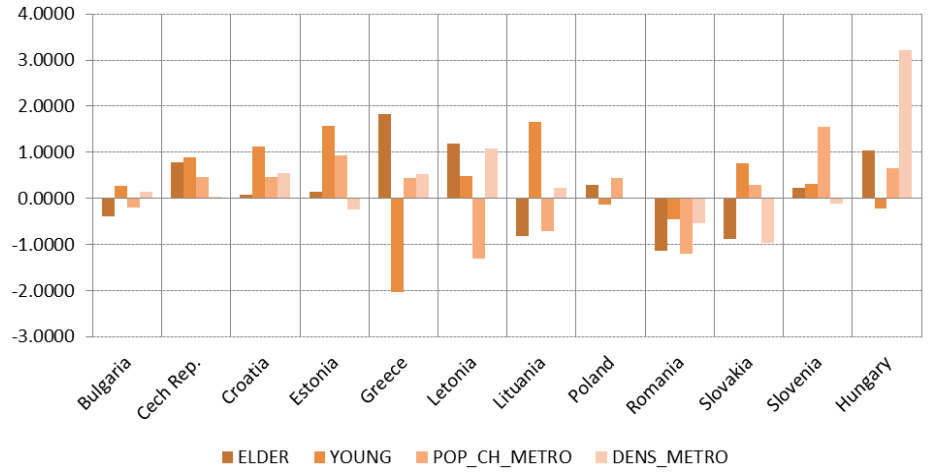
cities (Ljubljana) or industrial agglomerations such as the Katowice-Gliwice-Zabrze, Rybnik, Ostrava or the Gdansk-Gdynia harbour conurbation. The reduced densities within the metropolitan area - which shows a lower connectivity, but also the fact that there are significant reserves of space- are found in the case of the Baltic capitals and some Romanian cities without a consolidated polarised area, which is often a consequence of environmental conditions (lying in mountain areas or near extensive wetlands, as in the case of the Galați-Brăila agglomeration).

The presence of the very young population (aged 0-14) is simultaneously a sign of vulnerability in case of hazardous events, but also a mark of long-term vitality, ensuring the continuity and stability of the analysed cities. In the latest year with complete data for all cities (2014) the largest share of the young population (over 15%) can be found in the capitals of two Baltic States (Vilnius and Tallinn) due to national attractiveness in the absence of urban competition, Rybnik or Iasi (the main urban centres of some regions showing a positive demographic balance), all increasing if compared to the 2011 situation. The lowest ratios from cities such as Brașov, Galați-Brăila, Timișoara or Lodz and Walbrzych (under 13%) are due to low values of birth rate.

Regarding the share of the elderly population (over 65 years old) - indicating more vulnerability in case of significant long-term increase, the highest shares are registered in old industrial agglomerations from Poland and Czech Republic - Lodz, Brno, Katowice-Gliwice- Zabrze), in Thessaloniki, but also in capitals such as Riga or Budapest (over 19%). In some cases, higher life expectancy at birth can be invoked in the context of high quality medical infrastructure investments (Thessaloniki or Budapest). The lowest percentage of elderly people is in Romanian cities such as Iași, Galați, Timișoara, Cluj-Napoca and Rybnik, Kosice (less than 15%), whose urban expansion was manifested especially in the last decades of the communist period, but the general tendency for most cities is the increasing share of elder population.

If we aggregate data for the national level (see Figure 2) one can observe the differences between all 12 countries taken into account, which highlights the good position of countries such as Estonia or Slovakia (lower share of elder population, high percent of young population, positive metropolitan change and lower densities) and certain vulnerabilities when it comes to Greece or Hungary (attractive cities but a high percent of elder population and high densities).

Figure 2. Demographic resilience of cities - indicators at national scale



Source: own representation

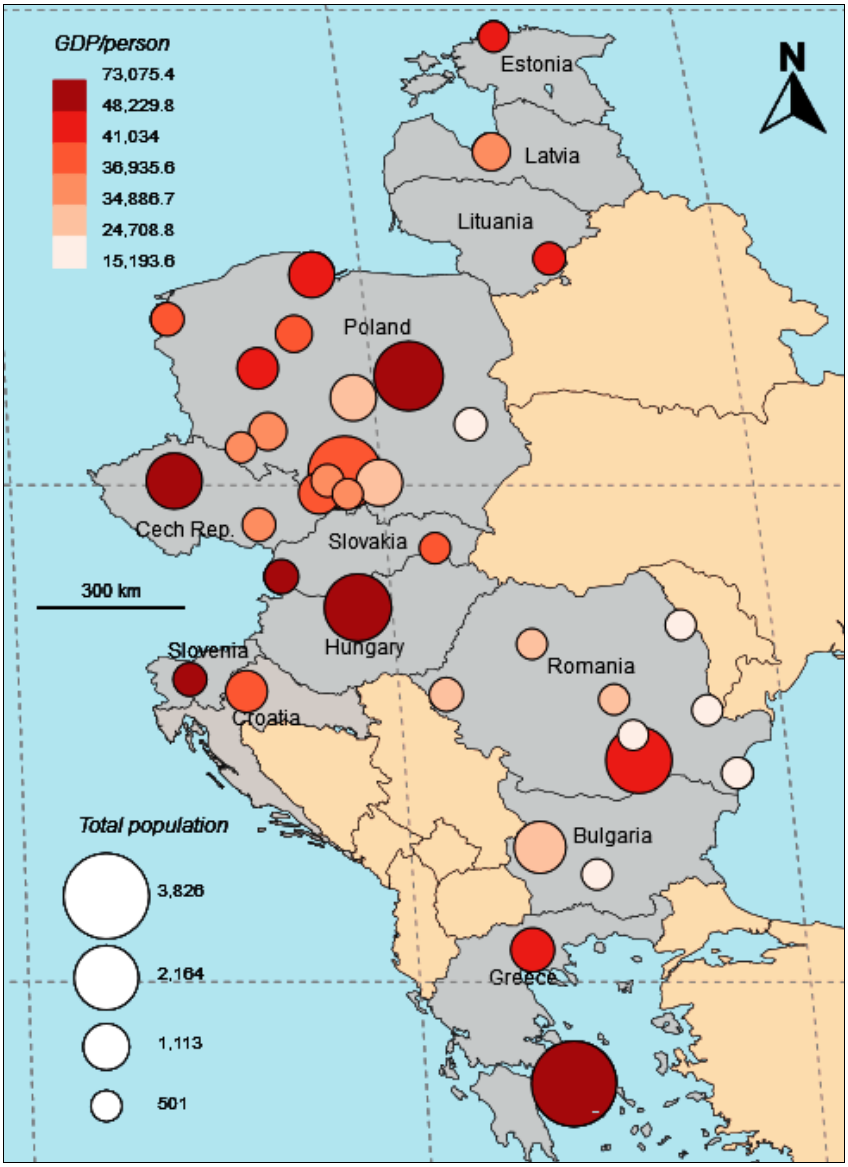
Social-economic resilience

The *availability of jobs* relative to the total population, in its recent evolution, shows major differences between formerly industrialized cities that have not fully reformed their economic profile (Szczecin, Gdansk, Poznan in Poland, etc.) and other cities such as Zagreb, Kosice, Ljubljana, or even Thessaloniki. A good job offer is found in some relatively dominant capitals within their own national urban system (Bratislava, Prague, Bucharest, Sofia), but also in Warsaw or Lodz. In 2006-2009, during the global economic meltdown, the decline in jobs affected more the Baltic capitals (Riga, Tallinn, and Vilnius), but also Budapest or Prague, in contrast to some Polish cities (Gdansk-Gdynia, Lublin, Rybnik, Bielsko - Biala, Katowice-Gliwice-Zabrze, Bydgoszcz-Torun, Lodz, and Warsaw) or Sofia. In the case of Poland, this rather uncommon development reflects the market economy consolidation policies that recommend it as a model for the Eastern European countries, being the only country where the recent economic crisis has been felt insignificantly.

If one takes into account the evolution of the *gross domestic product per capita* (see Figure 3)., a certain growth between 2000-2007 is registered for all the cities - especially the capitals of the Baltic States, Bratislava, Athens, Bucharest and the Romanian cities already integrated in the international economic circuits (Timișoara-Arad, Cluj-Napoca, Constanța). Some Polish cities (Szczecin, Lublin, Bydgoszcz-Torun, Lodz, Gdansk, Poznan), but also Thessaloniki have low increases. During 2007-2009, the crisis mainly affected the Baltic cities showing

decreases between 6.32 -11.08%, as well as Cluj-Napoca, Kosice and Thessaloniki. This demonstrates the vulnerability of recent economic redevelopment and the volatility of some economic branches in the context of dependence on international capital (for e.g. the well-known case of Nokia in Cluj-Napoca).

Figure 3. GDP per capita (2009) in large cities of Eastern European Union

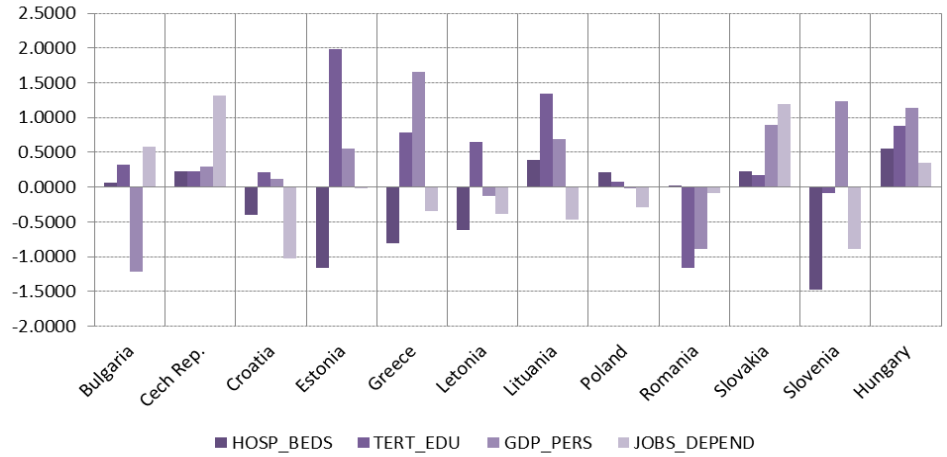


Data source*:* EUROSTAT, Made with MAGRIT

As regards the human capital, expressed by *the share of the population with higher education*, capital cities have more than 35% of the population over 25 years of age in this category (Tallinn, Prague, Vilnius, Sofia, Bratislava, Warsaw, Athens, Budapest, and Bucharest), closely followed by Riga. The lowest percentage of the population with higher education is found in the metropolitan areas of Romanian cities (below 17.5%), except for the capital, which demonstrates a certain delay of the urban transition process, somehow forced by the fall of the totalitarian regime that intended to create urban concentration *in situ* and not outside the city.

If one analyses *the number of hospital beds per 100,000 inhabitants*, the most advantageous situation is shown by a number of cities in Poland (Szczecin, Bydgoszcz-Torun, Walbrzych, Wroclaw) and by some capital cities (Bucharest, Prague, Bratislava, Vilnius) with over 750 beds/100,000 inhabitants. At the opposite pole - Ljubljana, Tallinn, Poznan and Ploiești have less than 500 beds per 100,000 inhabitants, expressing either the low potential of attraction (in the case of small states) or an excessive dependence on the infrastructure of nearby metropolises (in case of Ploiești).

Figure 4. Social-economic resilience of cities- indicators at national scale



Source: own representation

At the national level (see Figure 4), one can differentiate high values for all social-economic resilience indicators taken into account in Czech Republic, Hungary and Slovakia, and lower values in the case of Romania, showing lower economic competiveness. Nevertheless the high differences between the profiles indicate a certain "lock-in" particular trajectory of social and economic development for each of the countries (Drobniak, 2012).

Spatial-environmental resilience

High density cities have consequently the largest percentage of artificial surfaces, for example, the Greek cities of Athens and Thessaloniki, followed by capitals such as Bucharest, Budapest, Tallinn, Zagreb and Warsaw, if considering the entire metropolitan area, to which one can add Prague and Vilnius, as well as Polish agglomerations such as Rybnik and Katowice-Gliwice-Zabrze. In the latter case, the explanation is related to the presence of vast mining activities nearby. The lowest percent of artificial areas, thus providing the largest reserves of land that could be used in the future, are recorded in the Romanian cities (Brașov, Timișoara-Arad, Cluj-Napoca, Galați, Brăila), some cities in Poland (Bielsko-Biala, Szczecin), but also in the capital of Slovakia. As for metropolitan areas, the lowest values are those of Plovdiv, Bydgoszcz-Torun, and Brașov, but also of capitals such as Zagreb or Ljubljana, with large reserves of territory in the immediate vicinity.

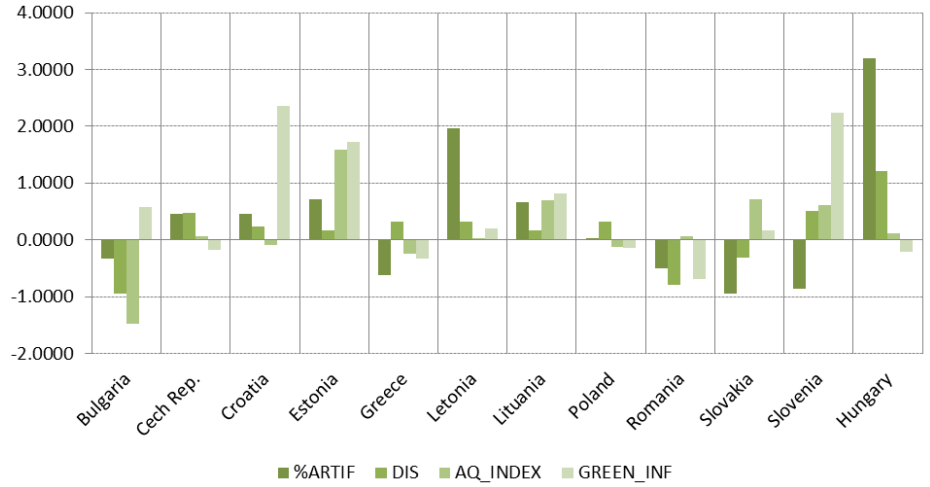
If analysing the urban sprawl, the capital of Prague, Athens and Bucharest or even Budapest, but also many of the Polish industrial agglomerations (Bielsko-Biala, Rybnik, Katowice-Gliwice-Zabrze, Krakow or Lodz) have the highest values of the dispersion indicator. Lower values of the spatial dispersion are to be found in the city of Plovdiv, but also in Timișoara, Brașov, Constanța and Galați-Brăila in Romania, Kosice in Slovakia and Brno in Czech Republic, where urban sprawl is more recent or limited by the presence of large wetland areas or harbour infrastructure (such is the case in Galați-Brăila and in Constanța).

In terms of air quality, the smallest values of small particulate matter ($PM_{2.5}$, PM_{10}) originating from both traffic and industrial activities are found in Tallinn, Gdansk, Thessaloniki, Brasov, Szczecin, Ljubljana, therefore in coastal or mountainous position. The highest values for particulate matter were measured in Plovdiv and Sofia (Bulgaria), Rybnik, Krakow, Bielsko-Biala, Lodz (Poland), but also Iasi or Bucharest (Romania) or Ostrava (Czech Republic). For NO_2 – that is mainly emitted from traffic, the highest values correspond to cities in Romania (Bucharest, Brasov), Poland (Wroclaw, Krakow), but also Athens or Plovdiv, while Galați-Brăila, Gdansk-Poznan-Lublin registered the lowest values. Overall, air quality is good in cities such as Galati (after reducing the activity of the steel factory), Tallinn (which has implemented emission reduction measures for example by introducing free urban public transport), but also Gdansk-Gdynia, Thessaloniki, Poznan or Kosice. Major problems are faced in Southern capitals (Bucharest, Athens, Sofia) or in other cities in the same region (Plovdiv, Brasov), but also in Poland (Wroclaw, Rybnik, Krakow), correlated with either excessive population density (Athens), traffic congestion (Bucharest) or the presence of polluting industries.

In direct connection with the previous indicator, the presence of and the access to green infrastructure strengthens resilience of urban areas. Cities and metropolitan areas with a high share of green area are capitals such as Zagreb, Ljubljana, Tallinn,

Sofia or Vilnius. From Romania only Brasov is on a top position in the hierarchy, while most of the others fall into the category of cities with a low share of green areas and green infrastructure in general, which is the effect of the lack of interest shown by local authorities for such facilities, considered to be “unproductive".

Figure 5. Spatial-environmental resilience of cities- indicators at national scale



Source: own representation

At national level, the highest values for all spatial-environmental resilience indicators are registered in Estonia and Lithuania, while the lowest can be found in Romania and Bulgaria (see Figure 5). Nevertheless, as it is the case for all three categories taken into account, country profiles are rather different, showing distinctive patterns and approaches in all Central-Eastern Europe countries that are presently integrated in the EU.

3.2. The Multi-Criteria Analysis

The actual values and multiannual dynamics of the selected indicators reflect certain issues that grant resilience or create vulnerabilities to large urban agglomerations in the Eastern European Union.

When analysing the Pearson correlation matrix (see Figure 6), one could notice significant positive correlations between some of these indicators: the density of the metropolitan areas correlates, to a large extent, with the dispersion of urban areas (0.645), suggesting that attractive urban areas have often evolved by unplanned expansion. However, the population density is also correlated with large shares of population with higher education (0.585) and with high GDP per capita values (0.505), these two being directly related to a significant increase in the total

population of the city and the metropolitan area (0.581 and 0.578). Also, the large number of jobs available is correlated with the presence of higher education units and the high share of the population with higher education (0.445), but also with a higher share of elder population (0.443). Positive correlations are also observed between the dispersion of urban GDP per capita (0.616) and the population with higher education (0.653).

Figure 6. The relations between resilience indicators - Pearson correlation matrix

%ARTIF	**1.000**										
DIS	**0.636**	**1.000**									
AQ_INDEX	-0.071	-0.311	**1.000**								
GREEN_INF	-0.043	0.061	0.047	**1.000**							
HOSP_BEDS	-0.002	0.050	-0.297	-0.089	**1.000**						
TERT_EDU	**0.542**	**0.653**	-0.075	0.287	0.111	**1.000**					
GDP_PERS	0.315	**0.616**	-0.010	0.254	0.070	**0.722**	**1.000**				
JOBS_DEPEND	0.287	**0.392**	-0.113	-0.196	0.212	**0.445**	0.261	**1.000**			
ELDER	0.306	0.328	0.042	-0.033	-0.141	**0.470**	**0.457**	0.042	**1.000**		
YOUNG	0.248	0.176	0.001	**0.378**	-0.032	0.235	0.029	0.160	-0.313	**1.000**	
POP_CH_METRO	0.217	**0.499**	-0.006	0.294	-0.013	**0.581**	**0.578**	0.074	**0.443**	0.256	**1.000**
DENS_METRO	**0.845**	**0.645**	-0.250	-0.034	0.042	**0.586**	**0.505**	0.222	**0.422**	0.010	0.318
Variables	%ARTIF	DIS	AQ_INDEX	GREEN_INF	HOSP_BEDS	TERT_EDU	GDP_PERS	JOBS_DEPEND	ELDER	YOUNG	POP_CH_METRO

Source: own representation

All of these show a rather unsustainable model of urban evolution and a separation between economic resilience of the cities in question and a sustainable model of their territorial evolution, which induces obvious inconveniences to the environmental quality (negative correlation of -0.311, between urban dispersion and air quality). In conclusion, there is certain segregation between the first two forms of resilience and the third.

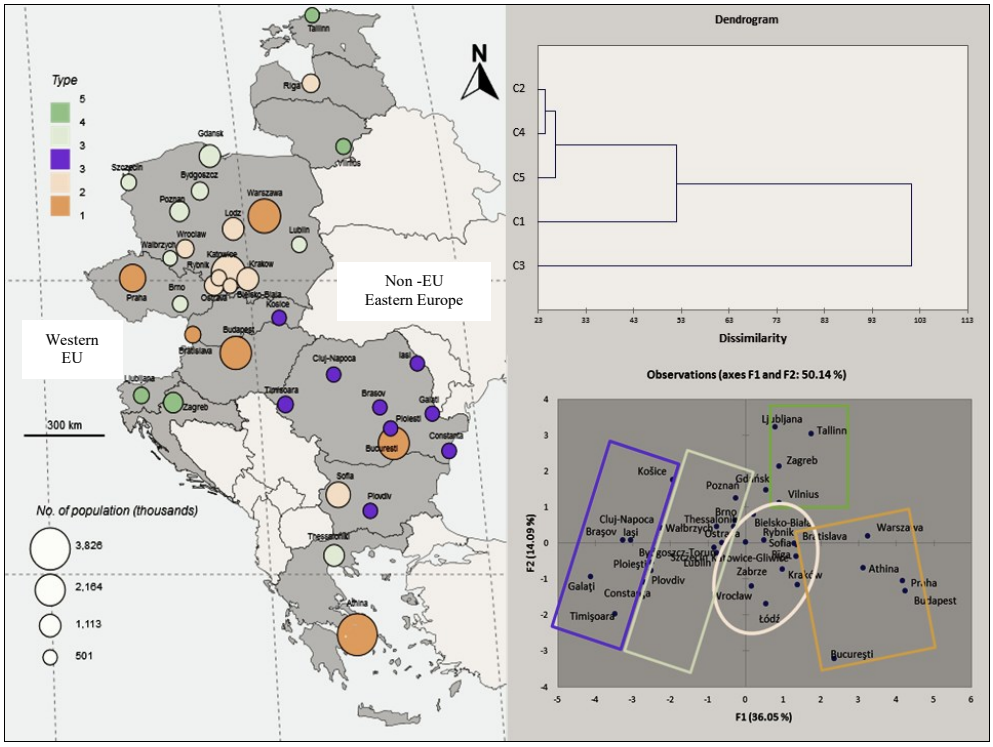
The indicators described and analysed above were introduced in a cluster analysis which results in establishing five categories/types of large cities in Eastern European Union:

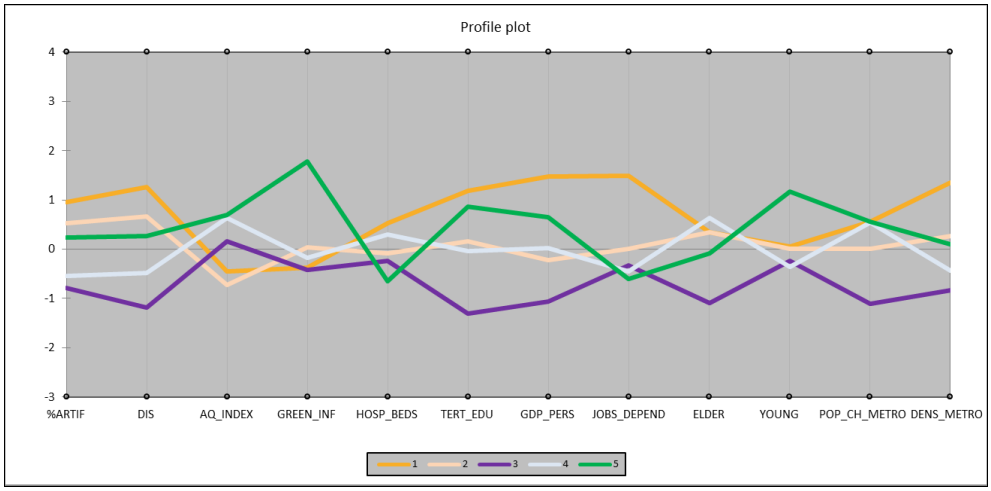
Type 1 - Includes dominant capital cities (Budapest, Warszawa, Bucharest, Bratislava, Prague, Athena), economically and socially resilient, but vulnerable in terms of spatial and environmental indicators. They show a high percentage of artificial surfaces, but also a large dispersion of the habitat. The GDP /person and the number of jobs relative to the population, with educational and medical services is far above the average values of the regional centres, but with low values of the air quality indicator and reduced availability of green areas.

An expression of the often excessive concentration of urban skills, on the background of systemic lack of maturity, the situation could be tackled by taking necessary decentralization measures at the national level, the only one capable of reducing both urban congestion and spatial vulnerability.

Type 2 – It is a cluster of metropolitan areas that are somehow similar to the previous ones in terms of environmental factors (ever worse if one takes into account urban air pollution), and with economic indices showing lower values (average values, if one considers the whole contingent of cities). They are regional poles (except for Riga – the capital city of Latvia), that were rather stable in the last period, but have a subordinate position within the urban systems of their states although they have a high competitive capacity which is needed for a balanced national urban system (Katowice-Gliwice-Zabrze, Lodz, Krakow, Rybnik, Wroclaw, Bielsko-Biala, Ostrava).

Figure 7. Typology of resilience features of metropolitan areas larger than 500,000 inhabitants





Source: own representation

Type 3 – Is a category of regional poles from Romania, Slovakia and Bulgaria that have a low economic and social resilience with reduced access to green areas. Meanwhile they have a relatively young population (low percentage of the elderly population) and a rather good air quality especially due to the closing of a big part of the classical industry developed during the communist period.

Type 4 **–** It is similar to the previous one, but with a more pronounced balance, with a higher social-economic resilience (close to average), but also with a higher percentage of the elder population. Most are Polish cities with diversified economy (Gdansk, Bydgoszcz-Torun, Lublin, Poznan, Szczecin, Walbrzych), but also regional poles from Greece (Thessaloniki) and Czech Republic (Brno).

Type 5 **-** Green capitals (Tallinn, Vilnius, Zagreb, and Ljubljana) are the most resilient by all three criteria. However, although GDP is above average and they have a relatively young population, their equipment with sanitary facilities is relatively deficient (low number of hospital beds /100,000 inhabitants) and the number of job opportunities for the population is rather low.

3.3. Discussions

The main hypothesis of the present work was that large cities from the Eastern part of the European Union share not only certain overall common patterns, depending on their path in recent decades, but also a different resilience capacity (if compared to the Western cities). Consequently, they should be divided in certain categories that result from applying certain indicators that illustrate their differentiated resilience capacity. The relation between urban transition and resilience should be studied more in depth, in a future paper, by taking into account

time series analysis in order to highlight the thresholds and phases of adaptation cycle.

Concerning the three categories of resilience indicators taken into account (demographical, social-economic and spatial-environmental) and the typologies that resulted after the statistical analysis, there are certain features that should be discussed.

More economic resilient, but facing complex social and environmental issues, the big capitals of Greece, Poland, Czech Republic, Hungary and Romania (Type 1) are subject to important and rapid transformations. Their resilience partially comes from the capacity to bounce back by appealing to higher social and economic resources, learning capacities and innovative potential, but also by benefitting from their more developed infrastructure, endowments and services.

Showing even more resilience attributes, the cities grouped in Type 5 are the small green capitals of Slovenia, Estonia, Lithuania and Croatia, rather sparsely populated with a generous territorial extension, fruitfully integrating their surrounding areas, having the advantage of almost exclusive attraction of foreign investments and concentration of superior functions at the national level and benefiting from a diversified industrialisation. They are old cities with strong historical roots: Hanseatic in the case of Tallinn, former royal capital (Vilnius), ducal capital (Ljubljana), or having a major defensive role at the borders of Habsburg Empire (Zagreb). In such an approach, smaller cities that are better connected to the territory manage to have a higher resilience capacity even if they lack the economic power of bigger capitals.

An East-West gradient can be observed when it comes to the three intermediary types. The cities from the Eastern part of the studied area (Type 3) face many constraints and drawbacks that are similar to those of non-EU Eastern Europe cities. Meanwhile urban areas included in Type 2 and, even more, those from Type 4, share many features with major Western European cities (Western Polish cities, but also Lublin and Thessaloniki).

Overcoming the most difficult transition process and being the least resilient, the Romanian cities (except for Bucharest) are grouped in Type 3 (together with Kosice and Plovdiv), which indicates certain homogeneity, but also general low values of most social, economic and environmental indicators. Nevertheless, in comparison to other types, the least ageing population and the more reduced processes of suburbanisation create reserves for resilience and future positive evolution.

By contrary, Poland has the most expanded and heterogeneous system of big cities (13 cities and agglomerations in three types), with a growing economic competition between cities and a certain East-West positive gradient of restructuration, connectivity and, by consequence, resilience. Differentiated policies are to be taken into account both by local and national authorities in order to create more functional relationships between Polish cities, to better use their potential to

create growth and employment and to regain certain urban socio-economic functions and endowments that were diminished or lost in the last decades (OECD, 2011).

The indicators reflect either vulnerability or resilience of cities (or both, in many cases) so that it is important not to draw outright conclusions on a certain hierarchy of their actual overall resistivity and adaptive capacity, but on the "patterns of resilience/vulnerability" created by urban transition that differentiate and define the analysed urban areas. Understanding the resulted typologies makes room for promoting differentiated policies towards tackling the vulnerabilities in a more coherent manner. Meanwhile, an overall framework for the dimensions of "urban resilience identity" in Eastern European Union can be identified by cumulating the features of different types of urban resilience.

In comparison to the over-planned character of former communist Eastern European Union cities, that put institutional barriers to social and geographical mobility and interactions, the large Western cities have a longer experience in urban governance and in promoting resilient institutions. This also results in another type of networking between cities based on complementarity and cooperation (Krunzman and Wegener, 1991). The polycentric structure of the Western urban system enhanced cooperative urban development (Pumain and Saint-Julien, 1996) that is a precondition for a resilient urban society. Meanwhile, spatial polarisation was not increased mainly by centralised decisions, but by early motorisation, construction of a more complex communication network, including high-speed transport infrastructure, and transformation of economic activities by industrialisation, but also by well-functioning services (as opposed to the delay of tertiarisation in Eastern Europe cities). Nevertheless, long term issues related to remaining contrasts between the core cities and the peripheries, urban sprawl, which was more prominent in this part of Europe, but also the ageing and decreasing urban population, de-industrialisation and suburbanisation that created shrinking cities (Platt, 2004, EEA, 2016a; EEA2016b), are able to diminish the overall higher resilience capacity of Western cities.

As a consequence, one could assess that the approach for reducing vulnerabilities and disparities for contributing to higher spatial coherence and adaptability in European Union is not adopting mimetic solutions– although best practice have to be taken into account – but integrating the peculiarities induced by the historical and political context, the features of the actual phase of the urban transition process that are reflected by current values of demographic, socio-economic and environmental factors of resilience.

Conclusions

There are different patterns and different stages in urban transition at the national level, but one can notice important differences between states even when similar policies were applied after 1990. This is a sign that transition to market

economy has not been completed yet, therefore the urban systems of the Eastern states of European Union did not reach the maturity phase.

This is also highlighted by a rather unsustainable model of urban development. There is a gap between social-economic resilience of the cities in question and a sustainable model of their territorial evolution that also includes environmental soundness.

If the results of multi-criteria analysis are taken into account, one can conclude that, in the analysed area of the European Union, many attractive cities have often evolved by unplanned expansion. Meanwhile, the cities that are more adapted to present economic and environmental challenges have higher educational services and GDP per capita, correlated to a higher number of jobs, but also a higher share of elderly population. The least correlated are the environmental indicators which show a lack of sufficient integration in development actions.

Meanwhile, the fact that most capital cities are the expression of the excessive concentration of urban assets, on the background of systemic lack of maturity is demonstrated. Decentralization measures at national level are highly necessary in most of the states, in order to reduce both urban congestion and spatial vulnerability. This will increase the overall resilience capacity. Potential alternatives and good practices for developing resilience capacity are the smaller green capitals – Baltic capitals, Ljubljana and Zagreb- that have a good air quality and access to green area, but also high reserves of young population.

To sum up, a resilient and sustainable city implies not just economic growth, rehabilitation of brownfields or controlled urban sprawl, but also ensuring a decent living standard in a healthy and safe environment in accordance to the principles of equal opportunities for the entire population. Therefore, assessing urban resilience capacity and performance by taking into account the actual state and the recent dynamics of the urban areas is a precondition in order to tackle more effectively the challenges of our world.

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