

REGIONAL DISPARITIES IN THE URBAN SPRAWL PHENOMENON IN ROMANIA USING CORINE LAND COVER DATABASE

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Abstract. Urban growth is one of the foremost spatial and functional processes in Romania, leading to an increase in the demand for housing, transport and infrastructure. Urban growth generally occurs dispersed throughout rural areas in the proximity of towns, under the form of urban sprawl. The current paper is seeking to assess urban sprawl in Romania after 1990 (the post-communist period) based on CORINE Land Cover (CLC) database. Two sub-periods were selected for this assessment (1990–2000 and 2000–2012) in relation to the particular political, socio-economic and decisional transformations. Given the regional particularities of land use/cover changes and the way the socio-economic transformations have been manifested regionally, the current assessment has been performed for each Development Region of Romania (NUTS 2 level). The study identifies the intra- and inter-regional differences of urban sprawl in relation to the spatial and functional patterns of built-up areas expansion. Generally, urban sprawl occurs at the expense of arable lands, pastures and natural complex cultivation patterns especially inside and outside the cities limits (e.g., Bucharest, Cluj-Napoca, Iași, Oradea, Constanța). However, regional differences are visible in relation to the natural and socio-economic conditions. Hence, North-West and South-West Development Regions registered the highest shares of built-up areas (around 60%), while South-East and West Development Regions the lowest (under 50%). The results of the current study provide useful data on the urban sprawl in Romania, highlighting the regional differences of the phenomenon in order to support further planning and management of land resources and land consumption.

1. INTRODUCTION

Europe is characterised by higher urban growth processes, leading to an increase in the demand for housing, transport and infrastructure (EEA, 2016). It has been estimated that by 2020, approximately 80% of Europeans will be living in urban areas which will occur in a dispersed way throughout Europe's countryside, under the form of urban sprawl (EEA, 2011). Over the last decades, land use/cover in Europe has been subject to a variety of structural and functional transformations with significant impacts on the spatial patterns of land processes. Between 2000 and 2006 about 1,000 km² of land was covered every year by artificial surfaces (EEA, 2010). The expansion of residential areas and construction sites is the main reason for the increase in urban land coverage in Europe.

Sprawl can be defined as a pattern of urban and metropolitan growth characterised by a continuous outward extension of built-up areas beyond city limits (Brueckner, 2000; Squires, 2002) and its suburbs over the rural land located at the fringe (Patacchini and Zenou, 2009). The extent of urbanisation is mainly driven by population growth and large-scale migration, which controls the changes in land use patterns (Sudhira *et al.*, 2004). In other words, it can be described by low-density housing and commercial development, automobile-dependent commuting, land use fragmentation and change located on the fringe of cities mainly into the surrounding agricultural areas (Squires, 2002; EEA, 2006). As a result, the compact urban areas have constantly been replaced by diffusive, scattered, leapfrog, linear or clustered growth (Allen and Lu, 2003; Cheng and Masser, 2003; Wilson *et al.*, 2003; Berling-Woff and Wu, 2004) which consumes more land resources (Barnes *et al.*, 2001).

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These spatial processes involve significant social, environmental and economic consequences (Patacchini and Zenou, 2009), in many cases restricting the accessibility to natural resources (e.g. agricultural lands, timberland) (Barnes *et al.*, 2001).

In order to assess and understand the spatial dimension of urban sprawl, land use/cover change analyses (LUCC) are already receiving considerable attention for identifying and computing its extension and pattern (Arsanjani *et al.*, 2013; Sudhira *et al.*, 2004). The impervious or built-up areas are generally used as foremost parameters to measure urban growth (Torrens and Alberti, 2000; Barnes *et al.*, 2001; Epstein *et al.*, 2002; Sudhira *et al.*, 2004; Rahman *et al.*, 2011; Shahraki *et al.*, 2011). For this reason, the current paper is proposing a basic assessment of the urban sprawl process based on the built-up areas dynamics for the 1990–2012 period in order to: (1) to detect where specific built-up areas change occurs – hotspots of urban sprawl; (2) to identify which land use/cover categories are subject to change in relation to built-up areas dynamics (change transitions); (3) to assess the change rates in order to pinpoint the spatial and temporal dynamics of the phenomenon. Solving these research objectives will help support effective policymaking in terms of urban and regional development, land-use planning, and planning of transport and other infrastructure, such as health services, ecosystem services and biodiversity conservation.

2. STUDY AREA

Located in the South-eastern part of Central Europe, Romania is a medium-sized European state covering a surface of 238,391 km² and a population of 20,121,641 inhabitants (INS, 2011; Niculescu, 2016) (Fig. 1).

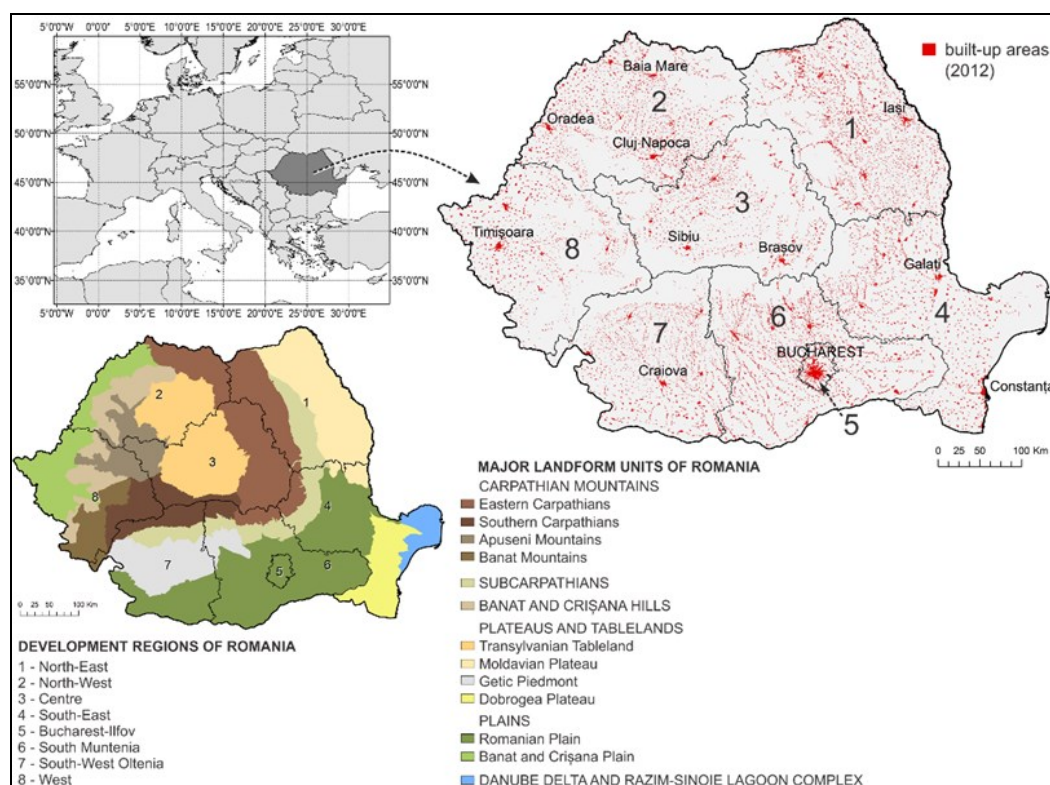


Fig. 1 – The Development Regions and the major landform units of Romania.
The built-up areas in 2012 (CLC database).

The diversity of land use/cover types stems from the variety of landforms, the moderate temperate-continental climate, the assortment of soil resources and the socio-economic conditions. Nevertheless, in relation to the local natural and socio-economic particularities, significant regional differences arise. Albeit the main land use categories are agricultural (61.2%) and forests (28.5%), built-up areas (3.1%) (INS, 2012) hold the largest population share. Within the general trends in urbanisation, some regions in Romania (e.g. Ilfov County) are known at European level for the high shares of urban population growth (Eurostat, 2016), setting off visible spatial transformations inside and outside cities.

The spatial differences of urban sprawl are more visible at regional levels. Thus, the authors have assessed urban sprawl phenomena at the level of Romania's eight Development Regions – NUTS 2 (North-West, Centre, North-East, South-East, South-Muntenia, Bucharest–Ilfov, South-West Oltenia and West). The Development Regions have been established in 1998 as territorial-statistical entities without legal personality in order to provide data for Eurostat estimations and for the absorption of European Structural Funds (Săgeată and Popescu, 2016).

3. METHODOLOGY AND DATA

The fall of the communist regime (1989) brought in a series of fundamental political and socio-economic changes commonly recognized as major drivers of territorial changes, grouped in two main periods: transition (1990–2003) and post-transition (2003 – to date) (Popovici *et al.*, 2013; Grigorescu *et al.*, 2015a). The transition period marked a significant change in the economy meant to replace the old centralised system by the free market system. Decollectivisation and privatisation of agriculture were the leading spatial and structural processes of this period which resulted in an overconcentration of the land property. The main consequences involved an excess fragmentation and abandonment of agricultural terrains (Popovici *et al.*, 2013), giving room to their conversion into other urban sprawl-related land use categories (e.g. residential, commercial). The post-transition period brought about changes related to the pre-accession and accession to the European Union and the implementation of the Common Agricultural Policy (CAP). These processes led to important land use/cover changes mainly associated with the *intensification* (internal conversion of agricultural land types from lower-to-higher intensity use) and *extensification* (internal conversion of agricultural land types from higher-to-lower intensity use) of agriculture, but also *urbanization and industrialization*, manifested by the expansion of the artificial areas (i.e. urban fabric, industrial, commercial) related to the decrease of the agricultural lands, semi-natural areas and forestlands (Kucsicsa *et al.*, 2018; Popovici *et al.*, 2018).

Following the political and socio-economic changes that took place after 1990 and their significance for the resulted spatial transformations in land use/cover pattern, the current assessment was performed for two relevant time-frames of the post-communist period. The analyses have been performed using Corine Land Cover Database¹, the only available free spatial datasets with national coverage at a relatively good resolution (equivalent to 1:100000 scale): 1990–2000 (T1) and 2000–2012 (T2). Thus, in order to identify these spatial transformations of the urban sprawl phenomenon in Romania, the authors generalised and used ten land use/cover categories according to the CLC level 3 nomenclature: built-up areas, arable lands, permanent crops, pastures, scrub and/or herbaceous vegetation association, forests, open spaces with little or no vegetation, heterogeneous agricultural areas, natural grasslands and agricultural complex cultivation patterns (Table 1).

¹ available at: European Environment Agency (Copernicus Land Monitoring Service) (<https://land.copernicus.eu/pan-european/corine-land-cover/view>)

Table 1

Land use/cover categories according to the CLC level 3 nomenclature

Main land use/land cover category	CLC nomenclature (level 3)
Built-up areas	Continuous urban fabric (111); Discontinuous urban fabric (112); Industrial or commercial units (121); Port areas (123); Airports (124); Construction sites (133); Sport and leisure facilities (142)
Arable lands	Non-irrigated arable land (211); Permanently irrigated land (212); Rice fields (213)
Permanent crops	Vineyards (221); Fruit trees and berry plantations (222)
Pastures	Pastures (231)
Scrub and/or herbaceous vegetation association	Moors and heathland (322); Sclerophyllous vegetation (323); Transitional woodland-scrub (324)
Forests	Broad-leaved forests (311); Coniferous forests (312); Mixed forests (313)
Open spaces with little or no vegetation	Beaches, dunes, sands (331); Bare rocks (332); Sparsely vegetated areas (333)
Heterogeneous agricultural areas	Annual crops associated with permanent crops (241); Land principally occupied by agriculture, with significant areas of natural vegetation (243)
Natural grasslands	Natural grasslands (321)
Complex cultivation patterns	Complex cultivation patterns (242)

In order to capture the spatial disparities of this complex phenomenon, the analyses have been carried out at regional level (Development Regions of Romania) and were completed by comparative environmental and socio-economic characteristics to explain the identified spatial changes.

4. URBAN SPRAWL IN ROMANIA. REGIONAL DISPARITIES

Urban sprawl has become the most notable pattern of urban development which, through urbanisation and suburbanisation processes, has significantly shaped the Romanian landscape over the last decades. Up to now, urban growth-related processes and their dynamics in Romania have been assessed in relation to their main explanatory driving factors (e.g. political, economic, demographic, and natural) at different spatial scales. A number of studies have addressed different urban development-related aspects at national level (e.g. Nicolae, 2002; Suditu *et al.*, 2010; Ioja *et al.*, 2011; Ianoş *et al.*, 2012; Petrişor, 2012; Mitrică *et al.*, 2016; Grădinaru *et al.*, 2015; Dumitrache *et al.*, 2016). At regional level, however, there is a wider variety of studies generally focusing on metropolitan regions (e.g. Bucharest, Constanţa, Iaşi, Suceava, Braşov, Cluj-Napoca) or other urban areas (Târgovişte, Sinaia), addressing topics such as: land cover/land use changes and spatial transformations (Simion, 2010; Pătroescu *et al.*, 2011; Ioja *et al.*, 2011; Ioja *et al.*, 2014; Grigorescu *et al.*, 2012, 2015a), counter-urbanisation process and rural-urban fringe patterns (Ianoş *et al.*, 2010; Guran-Nica *et al.*, 2011; Guran-Nica and Sofer, 2012; Vlădeanu and Petrea, 2013), residential development (Niculiţă *et al.*, 2011; Grigorescu *et al.*, 2012; Grigorescu *et al.*, 2015b; Pocol and Jitea, 2013), suburbanization and metropolization processes (Erdeli and Simion, 2006; Dumitrache *et al.*, 2016; Guran-Nica *et al.*, 2016), causes and consequences of urban sprawl (Iaţu *et al.*, 2011; Sârbu, 2012; Cocheci, 2014; Iaţu and Eva, 2016) or different socio-demographic processes taking place at the urban-rural interface (Sârbu, 2012; Istrate, 2015; Cocheci and Mitrea, 2016).

After the fall of communism, the intra- and inter-regional disparities in Romania have been mainly explained by some phenomena which involved: urbanisation/suburbanisation, where growth was mainly concentrated in and around large cities (e.g. Bucharest, Iaşi, Constanţa, Cluj-Napoca, Braşov) developing new urban-rural relationships and metropolitan areas (Grigorescu and Kucsicsa, 2017); industrial decline which have affected the former industrialised regions during the socialist period (South-West Oltenia, North-East and partly South-Muntenia); predominant agricultural-rural – based local economies (South-Muntenia); mountain areas affected by stagnation or recession (Centre);

foreign investments (Bucharest–Ilfov) (Popescu *et al.*, 2016; Bălteanu *et al.*, 2016a). All of these help explain the key urban sprawl-related features (pros and cons), which justify the different growth potential of each development region (Table 2).

Table 2

Key urban sprawl-related features of the development regions in Romania

Development Region	Key urban sprawl-related features
<i>South-Muntenia</i>	pros – extended land resources (e.g. agricultural areas); industrial renewal due to foreign investments (e.g. Pitești, Târgoviște, Ploiești); cross border cooperation and improved connectivity with Bulgaria (Giurgiu–Ruse bridge, Turnu-Măgurele – Nikopol ferry); one growth pole (Ploiești); one development pole (Pitești) cons – significant intra-regional disparities; industrial decline and unemployment (e.g. Turnu Măgurele, Oltenița, Călărași, Zimnicea)
<i>South-East</i>	pros – significant natural resources (e.g. fertile soils, agricultural areas, mineral resources, oil and gas); accessibility and diversity of transport infrastructure (including maritime – Constanța harbour); one growth pole (Constanța) with the most developed economy, foreign investments and metropolitan area; development poles (Galați, Brăila) with revived industry and growth potential, seeking to develop a bipolar metropolitan area; other towns undergoing industrial rehabilitation: Năvodari, Mangalia, Buzău cons – dominant agricultural economy; post-communist industrial decline and unemployment (e.g. Râmnicu Sărat, Medgidia)
<i>North-East</i>	pros – the most extended and populated; rather higher industrialisation rates in Bacău, Neamț and Iași Counties; one growth pole (Iași) which is the most dynamic city in terms of industrial development and suburbanisation (metropolitan area); two development poles (Suceava, Bacău) cons – the lowest values of the economic indicators; low industrialization level; highest employment in agriculture; one of the less attractive areas for foreign investments
<i>North-West</i>	pros – diversified economy mainly based on agriculture, industry and services with high growth levels in Cluj and Bihor Counties; one growth pole (Cluj-Napoca), the most developed city known for the concentration of industries, services and foreign investments; three development poles (Oradea, Satu Mare, Baia Mare); metropolitan development (Oradea, Cluj-Napoca, Baia Mare, Satu Mare) cons – slight intra-regional disparities between the more industrialised counties (Cluj, Bihor, Satu Mare, Maramureș) and the less developed (Sălaj and Bistrița Năsăud)
<i>Centre</i>	pros – diversified economy and high industrial development (mainly energy, aeronautics, chemical fertilizers); foreign investments (Brașov, Sibiu, Târgu Mureș); one growth pole (Brașov); two development poles (Sibiu, Târgu Mureș); metropolitan development (Brașov, Târgu Mureș) cons – extended mountain areas affected by stagnation or recession (Harghita, Covasna Counties); industrial decline (former mining areas in Hunedoara and Alba Counties)
<i>West</i>	pros – diversified natural resources and economy; cross-border cooperation; most of industry and foreign investments concentrated in Timiș and Arad Counties; cross border cooperation and improved connectivity with Hungary; one growth pole (Timișoara); two development poles (Arad, Deva); metropolitan development (Deva, Hunedoara, Simeria, Timișoara); cons – significant intra-regional disparities between Timiș County and the three less developed counties (Arad, Hunedoara and Caraș-Severin)
<i>South-West Oltenia</i>	pros – predominantly agriculture and industry-based economy with some major investments in Craiova, Slatina, Târgu Jiu; cross-border cooperation and improved connectivity with Bulgaria (Calafat–Vidin Bridge, Bechet–Oreahovo ferry crossing) and Serbia (Drobeta Turnu Severin–Kladovo); one growth pole (Craiova) with the highest development potential through the aircraft and locomotive factory; one development pole (Râmnicu Vâlcea) cons – the poorest region in terms of contribution to the national GDP; relatively low industrialization level; negative environmental impact triggered by the energy and mining industry (Turceni, Rovinari and Ișalnița thermal power plants)
<i>Bucharest–Ilfov</i>	pros – the highest contribution to the national GDP; large share of built-up areas; complex agriculture, combining rural with suburban farming; high concentration of foreign investments; the industry is mainly related to the urban market and the multinational companies headquarters; service sector holds 83% of all active enterprises; continuous spatial and functional expansion of Bucharest over the surrounding territory (urban sprawl-suburbanization), especially through residential and commercial development cons – deindustrialization of Bucharest economy and relocation of some companies in Ilfov County; economic disparities between Bucharest and Ilfov County, with different economic characteristics

The variety and dynamics of the main land use/cover categories and socio-economic processes are visible in the inter-regional disparities of the Development Regions. Built-up areas, considered as growth nuclei for future urban sprawl, prevail in the South-Muntenia and North-West Development Regions where some of the biggest cities of Romania are located (e.g. Cluj-Napoca, Oradea). However, areas with natural restrictions for urban growth are located in the South-East Development Region, mainly due to presence of the second largest delta in Europe (Danube Delta). Moreover, the largest share of urban growth-prone land resources (e.g. arable lands, pastures, natural grasslands) is found in the South-Muntenia Development Region, South-East Development Region, Centre and West Development Regions and South-East and South-West Oltenia Development Regions.

5. RESULTS

5.1. Built-up areas dynamics in the 1990–2012 period

According to the CLC database (Fig. 2), after 1990 built-up areas are among the main land use categories subject to significant dynamics in Romania. Hence, between 1990 and 2012, built-up areas almost doubled, with different increases between the two analysed intervals: 33.8% during the 1990–2000 period and 13.1% during the 2000–2012 period. The overall annual rate reached about 45,664 ha, with 49,045 ha during the 1990–2000 period and 21,142 ha during 2000–2012 period.

Regionally, the highest built-up areas increases between 1990 and 2012 were registered in the North-East (155,400 ha) and North-West (121,750 ha) Development Regions, while the smallest in the Bucharest-Ilfov Development Region (17,700 ha). However, the highest expansion shares were registered in the North-West (60.8%), South-West Oltenia (58.4%) and Centre (56.2%) Development Regions, while the lowest in the South-East (45.1%), Vest (46.1%) and North-East (46.5%) Development Regions.

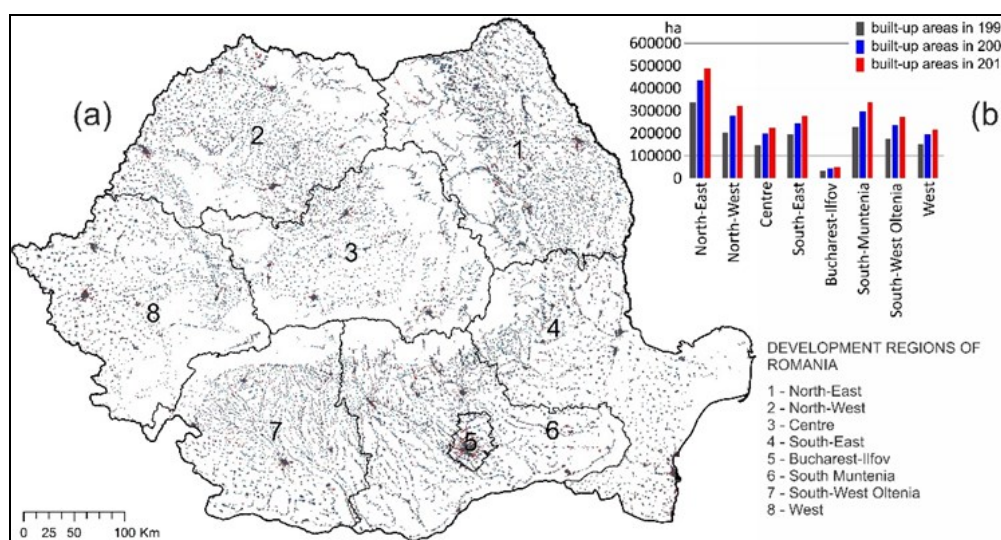


Fig. 2 – Built-up areas dynamics during the 1990–2012 period (a) and its distribution in the Development Regions of Romania (b) according to the CLC database.

At LAU level, the highest built-up areas expansion (1990–2012) was recorded inside very large and large cities such as Bucharest (3,175 ha), Oradea (1,850 ha), Braşov (1,600 ha), Arad (1,575 ha), Constanţa Cluj-Napoca (1,325 ha each) and Iaşi (1,275 ha). Also, significant increases were registered

by some small towns or rural settlements located in the surrounding territories or metropolitan areas of very large and large cities: e.g. Voluntari (950 ha), Popești-Leordeni (925 ha) and Snagov (825 ha) in Bucharest metropolitan area or Miroslava (925 ha) in Iași metropolitan area. Some differences are noticed between the two sub-intervals (Fig. 3). During 1990–2000, built-up areas expansion occurred quite evenly throughout the Romanian territory with higher values inside very large and large cities and lower values in the mountain regions or rural areas. However, after 2000 the general urban expansion pattern has changed visibly. Significant increase is mainly concentrated inside very large and large cities, but also in some small towns and rural settlements located in metropolitan areas or under the influences of different-size cities (e.g. Popești-Leordeni, Miroslava, Voluntari, Otopeni). This tendency of built-up areas expansion is mainly driven by the suburbanization process which is the main urban growth-related spatial process taking place in the two last decades.

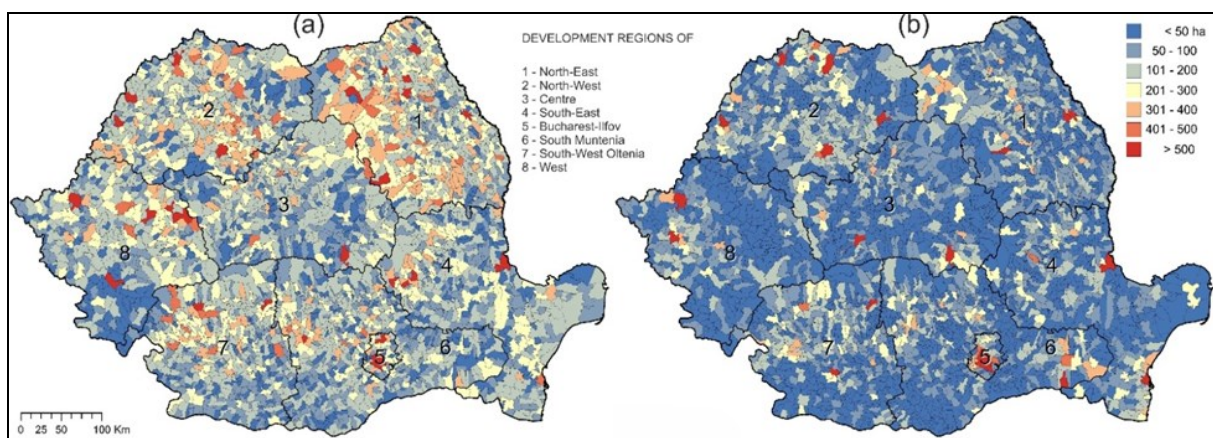


Fig. 3 – Built-up areas dynamics during the 1990–2000 (a) and 2000–2012 (b) periods at LAU level according to the CLC database.

In terms of land use/cover transition, built-up areas increase in relation to arable lands, pastures and agricultural complex cultivation patterns were the most important land use conversion types occurred during the 1990–2012 period, totalling nearly 77% of the total changes related to built-up areas expansion. These changes took place mainly in the Bucharest–Ilfov, South-East and North-East Development Regions. However, between the two analysed sub-periods, the share of changes was maintained slightly the same with differences between the three land use categories: the conversion from arable lands into built-up areas increased from 36.9% to 45.2% while pastures, the second land use category to be converted to built-up areas in the first period (26.1%), were significantly reduced (12.7%) in the second, being replaced by agricultural complex cultivation patterns (19.5%).

At regional level, the most significant land use conversion into built-up areas took place at the expense of agricultural areas in Bucharest–Ilfov (71%) and South-East (49%) Development Regions, of pastures in West (32.6 %) and North-West (24.4 %) Development Regions and of agricultural complex cultivation patterns in South-West Oltenia (19.7%) and North-West (19.4%) Development Regions. However, permanent crops and heterogeneous agricultural areas were also subject to conversion in large shares in South-East (12.8%). Centre (14.6%) Development Regions, respectively. Lower conversion shares involved open spaces with little or no vegetation, natural grasslands and scrub and/or herbaceous vegetation association land use/cover categories. Compared to T1, during T2, an increase in the conversion shares of agricultural lands into built-up areas occurred in almost all Development Regions, with highest values in Bucharest Ilfov (from 63.6% to 77.9%), West (from 29.3% to 43.3%) and South-East (from 45.6% to 55.6%) Development Regions. Concurrently,

agricultural complex cultivation patterns increased in importance (especially in North-East, South-West Oltenia and North-West Development Regions), while pastures registered significant decrease (mainly in North-East, South-West Oltenia and South-Muntenia), generally pinpointing a shift between these two land use categories in terms of conversion to built-up areas. In addition, during T2, permanent crops emerge as a new land use category with significant conversion potential, especially in South-East, South Muntenia and South-West Oltenia Development Regions.

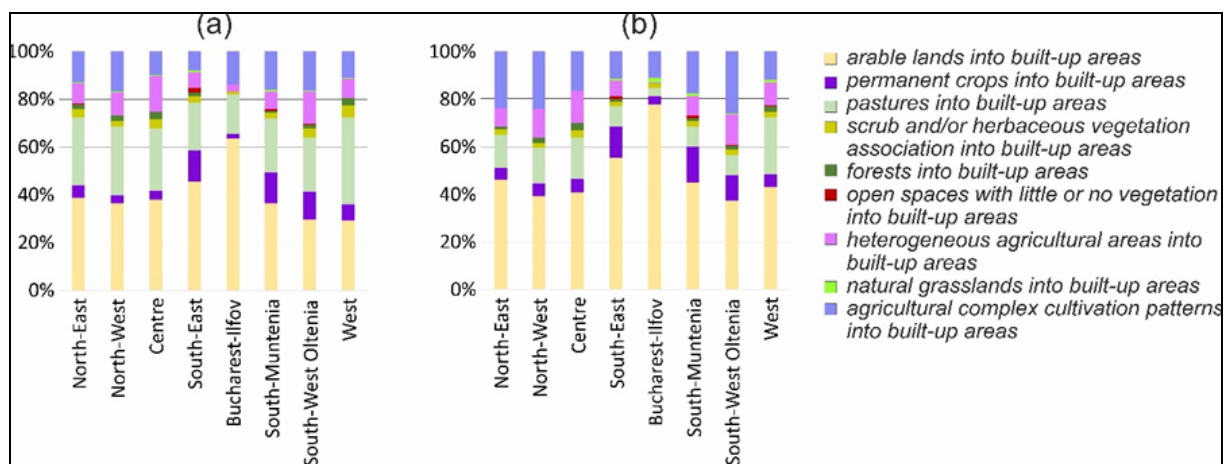


Fig. 3 – The main land use/cover transitions to built-up areas during the 1990–2000 (a) and 2000–2012 (b) periods in the Development Regions of Romania according to the CLC database.

5.2. Regional differences

Significant intra-regional differences are noticed in relation to the particular natural and socio-economic features of each development region.

The **North-East Development Region** is characterised by the lowest values of macroeconomic indicators due to the lower labour productivity and biggest share of the employed population in agriculture (Popescu *et al.*, 2016). However, the highest number of inhabitants, the extended land resources, the overdevelopment of some towns (e.g. Iaşi, Suceava) justify the largest built-up expansion of the region after 1990 (155,400 ha; 46.5%). Between 1990 and 2000, under the positive social and economic development of the transition period, the built-up areas expansion has registered significantly higher rates (107,175 ha; 32.1%), almost three times higher than the second sub-period (2000–2012). One of the main built-up expansion was registered in Iaşi (550 ha), which is the most dynamic city in terms of education and culture, industrial development (*Antibiotice Iaşi*, creative industries – *Technopolis Industrial Park*) and suburbanisation processes in its metropolitan area. Other important growth rates were recorded by large, medium-sized and small towns such as: Dolhasca (600 ha), Suceava (525 ha), Piatra Neamţ and Bacău (275 ha each), Oneşti (225 ha) mainly related to the location of important industrial companies (e.g. *Rafo Oneşti*, *Aerostar* and *Letea Bacău*, *Rifil Piatra Neamţ*) (Bălteanu *et al.*, 2016a), as well as to the money inflows from the family members working abroad. Under T₂, the continuous economic restructuring in most of towns, the poverty, the high unemployment rate and the poor accessibility to social infrastructure (health services and education) and technical endowments (e.g. drinking water, sewage) in the rural areas triggered an overall lower built-up growth (48,225 ha, which is 10.9%). However, several towns continue to register higher built-up expansion rates compared to T₁: Iaşi (725 ha), Bucecea (400 ha), Vaslui (350 ha), Bacău (375 ha), Piatra Neamţ (300 ha) etc. Also, under the suburbanization process, important growth was also

registered in some LAU located in the influence area of large towns. E.g. Miroslava (625 ha), Ciurea and Tomești (275 ha each) located in Iași metropolitan area. The development of tourism in some Carpathian and Subcarpathian localities has also led to significant built-up areas increase driven by the development of touristic infrastructure: e.g. Moldova-Sulița (375 ha), Campulung Moldovenesc, Sadova and Dorna Căndrenilor (350 ha each), Vatra Moldoviței (300 ha).

Throughout the entire analysed period, lower build-up areas expansion have been mainly registered in the rural settlements located in Vaslui (e.g. Pogonești, Ivești, Ferești), Botoșani (e.g. Știubieni, Ripiceni), Suceava (e.g. Iacobenii, Pătrăuți, Botoșana, Comănești) or Iași (e.g. Focuri, Sinești, Tansa) Counties, where, in addition the socio-economic drivers, the natural limitations and the exposure to natural hazards are important restrictive factors for built-up area expansion. E.g. flash-floods, deep slides and mudflows in the mountain areas (Eastern Carpathians) and heavy rainfall, severe soil erosion, gullies, slides and mudflows in the hills and tablelands (e.g. Moldavian Plateau, Eastern Subcarpathians) which have a great impact on localities and infrastructure (Bălțeanu *et al.*, 2016b).

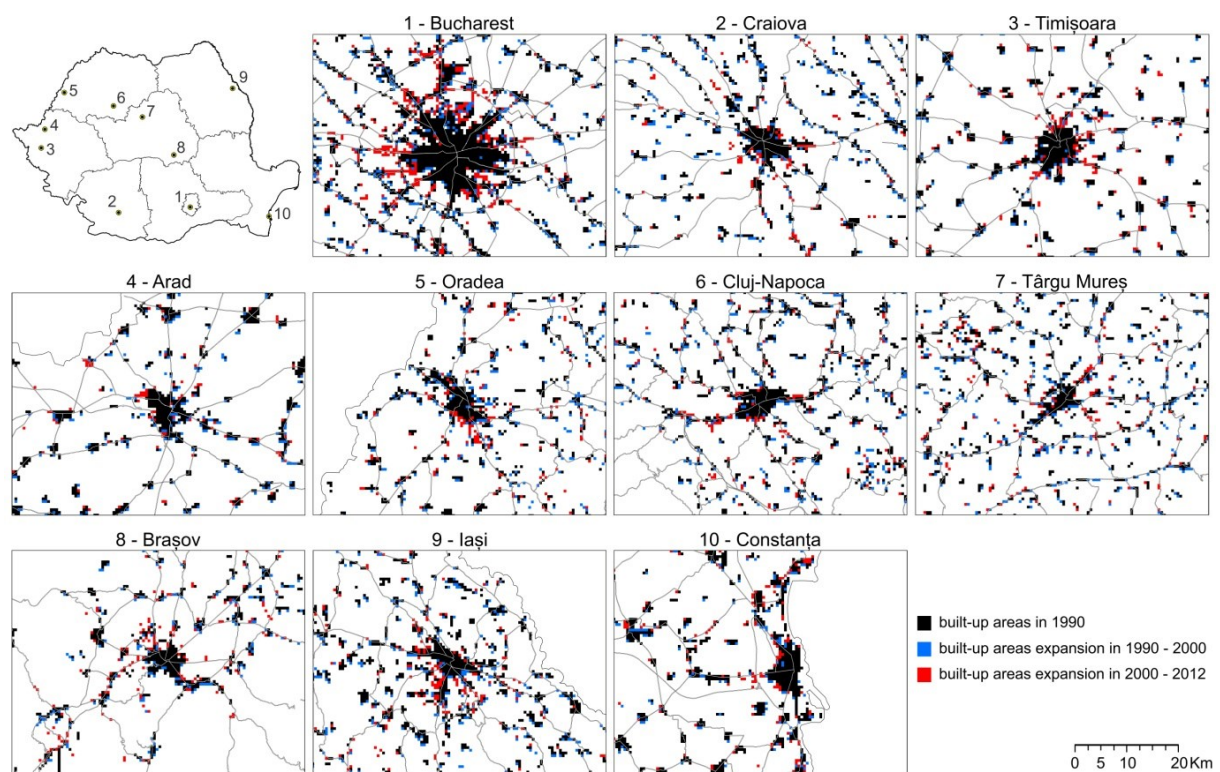


Fig. 4 – Urban growth in the 1990–2012 period in the some of the foremost cities in Romania.

North-West Development Region is among the most developed regions with diversified economy, which explains the high built-up expansion after 1990 (121,750 ha; 60.8%). The highest density of the road and rail communication network in Romania and the high potential for cross-border cooperation are among the main factors of attracting important foreign direct investments for the development of economy. Generally, the region maintains its spatial structure with three development levels: core (Cluj, Bihor), semi-periphery (Satu Mare, Maramureș) and periphery (Bistrița-Năsăud) (Popescu *et al.*, 2016).

Despite the general differences between the two analysed intervals (79,550 ha; 39.7% during T1 and 44,200 ha; 15.1% during T2), some towns have registered particular built-up areas expansion: Oradea (975 ha/T₁, 875 ha/T₂), Cluj-Napoca (650 ha/T₁, 675 ha/T₂), Bistrița (450 ha/T₁, 725 ha/T₂),

Satu Mare (625 ha/T₁, 525 ha/T₂), Baia Mare (400 ha/T₁, 625 ha/T₂), where the greatest part of industry and services were located (e.g. *Zahărul*, Oradea, *Napolact* and *Terapia* Cluj-Napoca, *Electrolux*, Satu Mare, *Teraplast*, Bistrița) (Bălteanu *et al.*, 2016a). Oradea and Cluj-Napoca, in particular, are multifunctional towns with important administrative, business, education and cultural profiles (Mitrică *et al.*, 2016). In addition, the urban development of Tăuții-Măgherauș, Florești and Recea, (Cluj-Napoca metropolitan area), Sînmartin, Cetariu, Paleu and Nojorid (Oradea metropolitan area) are related to the suburbanisation processes. Nevertheless, a significant number of LAU registered insignificant (<50 ha) built-up areas growth. The main restraining factors are related to the decline of some one-industry towns (e.g. Ștei in Bihor County and Câmpia Turzii in Cluj County), the natural seclusion and predominant rural profile of some villages in the Apuseni Mountains (e.g. Valea Ierii, Mărișel, Râșca in Cluj County, Criștioru de Jos in Bihor County) or in the Eastern Carpathians (e.g. Leșu, Rebrîșoara, Ilva Mică in Bistrița-Năsăud County, Lăpuș, Poienile Izei, Vadu Izei in Maramureș County).

Centre Development Region, also one of the economically developed regions with diversified economy, experienced a considerable built-up areas dynamics over the last decades. Differences between the two analysed intervals are maintained. Thus, during T₁ the region registered almost two times higher built-up areas expansion (53,525 ha; 37.2%) compared to T₂ (27,300 ha; 13.8%). Higher increases were registered in the towns of Brașov (675 ha/T₁, 925 ha/T₂) and Sibiu (500 ha/T₁, 650 ha/T₂) due to the location of important food industry (*Kraft Foods* Brașov, *Scandia*, Sibiu), metallurgy (*Sometra*) or aeronautics (*IAR* Brașov) (Bălteanu *et al.*, 2016a). Other factors involved the cultural and educational profiles, as well as the development of industrial parks in Brașov and Sibiu (hosting many subsidiaries of multinational businesses), urban sprawl and metropolitan development, as well as foreign investments and thriving tourism. All of these make a significant contribution to the local economic development that supports further urban growth. In addition, important growth was recorded in the towns of Alba Iulia, Târgu Mureș, Mediaș or Reghin in relation to the growing industrial development, mainly energy (e.g. *Romgaz* and *Transgaz* Mediaș), food industry (*Hochland Romania*, Mureș, *Elit*, Alba), chemical fertilizers (*Azomureș*) or to the emergent socio-economic and spatial growth in relation to the more dynamic suburbanisation-related processes. The industrial decline of some mining sites or one-industry towns (Dumitrescu, 2008) explains the higher share of LAU with insignificant urban growth (<50 ha) (e.g. Bălan in Harghita County, Valea Crișului, Vârghiș in Covasna County, Victoria in Brașov County, Ciuruleasa, Mogoș in Alba County). Moreover, the natural limitations given by the large extent of mountain areas in Harghita, Covasna and Alba Counties also posed restrictions to built-up areas expansion in the localities affected by spatial and social seclusion and reduced accessibility to transport infrastructure and services. It is the case of most of LAU located in the Apuseni Mountains (e.g. Poiana Vadului, Râmet, Ponor in Alba County) or in the Eastern Carpathians (e.g. Sânsimion in Harghita County; Bățani, Poian in Covasna County).

South-East Development Region registered the lowest urban growth (86,225 ha; 45.1%) because of the predominant agrarian profile or the industrial decline, as well as the lowest difference between the two sub-periods (55,025 ha; 28.8% in T₁ and 31,200 ha; 12.7% in T₂) compared to the rest of Development Regions. Nonetheless, the largest growth rates was recorded in Constanța (500 ha/T₁, 825 ha/T₂) due to its port-related functions (the main gateway of international maritime traffic in Romania) which makes it attractive for foreign direct investments (Săgeată and Popescu, 2016) and Galați (600 ha/T₁, 525 ha/T₂) supported by the national-level industrial plants (e.g. *ArcelorMittal*) and its position along the Danube River (the biggest fluvial-maritime harbour in Romania). Several towns which host important industrial activities, some of them rehabilitated after the post-communist industrial decline, also registered significant built-up areas expansion: e.g. Năvodari (300 ha/T₁, 350 ha/T₂) mainly in relation to the petrochemical industry (*KazMunaiGaz*), Mangalia (225 ha/T₁, 375 ha/T₂) due to the investments in the shipyards (*Daewoo-Mangalia Heavy Industries S.A.*, currently taken over by *Damen*) or Buzău (250 ha/T₁, T₂) driven by the support of the steel industry (*Ductil Steel*). The recent urban expansion of Mihail Kogălniceanu (225 ha/T₁, 275 ha/T₂) is related to the existence of

the international airport which, apart its transport function and military base, also offers industrial areas for storage and logistics which attracted workforce, infrastructure and housing. A particular case of built-up areas expansion is related to the increasing development of tourist activities along the Romanian Black Sea Coast (e.g. Năvodari, Mangalia, Corbu, Tuzla, Limanu)

On the other hand, a large number of LAU, including small and medium-sized towns, registered built-up areas decrease mainly in relation to the industrial decline (e.g. Pătârlagele, Nehoiu, Medgidia, Ovidiu), the high share of population employed in agriculture and unemployment rate (Chișcani, Berca, Vidra, Mera, Lopătari). Throughout the entire analysed period, some settlements are expecting insignificant built-up areas growth (<50 ha), especially in the localities with predominant agricultural-rural profile located in the south-eastern part of Romanian Plain (e.g. Movila Miresii, Făurei in Brăila County; Independența, Jirlău in Galați County), the Danube Delta (Pardina, Chilia Veche in Tulcea County), the Dobrogea Plateau (Gârliciu, Oltina, Valul lui Traian in Constanța County) or the southern part of the Moldavian Plateau (e.g. Rădești, Oancea in Galați County).

Bucharest–Ilfov Development Region registered reached 17,700 ha which, related to the overall surface of the region (the smallest Development Region) is one of the most notable urban growth shares of the whole analyse period (53.3%) and rather equally distributed between the two sub-intervals (24.2% in T1 and 23.5% in T2). This growth can be explained by the region's economic development with the highest contribution to the national GDP and the highest concentration of foreign investments (Bălțeanu *et al.*, 2016a). However, the economic disparities between the Capital-city and Ilfov County, with different economic characteristics and the continuous spatial and functional expansion of Bucharest over its surrounding territory (suburbanization) are visible in the different values of the growth potential. Thus, Bucharest registered the highest built-up areas expansion in Romania during both sub-periods (1,325 ha/T1 and 1,850 ha/T2) in relation to its multifunctionality which involves administrative, business, education and cultural profiles (Mitrică *et al.*, 2016). In addition, its industry underwent profound restructuring, thus some of the abandoned industrial platforms become available land resources for future residential or commercial uses. Nevertheless, the companies that have survived the restructuring process are mainly related to the urban market and multinational corporations that have their headquarters in the region: energy companies (*Electrica, Hidroelectrică, Electrocentrale, Transelectrica*), telecommunications (*Orange, Vodafone, Telekom*), or the tobacco industry (*BAT, Philip Morris, JTI*) (Bălțeanu *et al.*, 2016a). The relocation of some companies in Ilfov County, the suburbanization-related processes, mainly residential and commercial development (Grigorescu and Kucsicsa, 2017; Kucsicsa and Grigorescu, 2018) and the availability of land resources (mainly arable land) for expansion explain the relatively high potential growth of some LAU located in the inner suburbs of Bucharest. For instance, continuous increases during the two intervals were recorded in Voluntari (350 ha/T1; 600 ha/T2), Popești-Leordeni (275 ha/T1; 650 ha/T2), Otopeni (175 ha/T1; 575 ha/T2) Bragadiru (125 ha/T1; 450 ha/T2), Chiajna (125 ha/T1; 400 ha/T2), Mogoșoaia (75 ha/T1; 425 ha/T2) etc. Some traditional residential areas in northern and north-western Bucharest (e.g. Snagov, Gruiu, Periș, Buftea) have slowed down the urban growth process due to the already high pressure of residential development during the first period and the emergence of new development in the south and west (e.g. Popești-Leordeni, Bragadiru, Domnești, Dragomirești-Vale). Under certain limiting factors (e.g. the predominant agriculture-based economy, the limited accessibility to transport infrastructure and services, the high unemployment rates, the aging population) few LAU located in Ilfov County registered insignificant growth (<50 ha) after 1990 (e.g. Dărăști–Ilfov, 1 Decembrie, Grădiștea, Petrăchioaia, Dascălu).

The **South-Muntenia Development Region** was one of the areas with high industrialization, urbanization and agricultural development during the communist period, which partly explains one of the highest built-up area expansion 112,950 ha (50.0%) after 1990, significantly higher in the first interval (74,450 ha; 33.0%) compared with the second (38,500 ha; 12.8%). Under some industrial renewal due to new investments (e.g. *Unilever, Lukoil Petrotel and British American Tobacco* Ploiești,

Automobile Dacia Renault Pitești; *Samsung* and *Otelinox* Târgoviște), good transport connectivity (including cross-border cooperation – Giurgiu–Ruse Bridge) or proximity to urban areas, some localities experienced built-up areas increase during both sub-intervals: Călărași (325 ha/T1; 572 ha/T2), Pitești (375 ha/T1; 400 ha/T2), Ploiești (325 ha/T1; 350 ha/T2), Slobozia (250 ha/T1; 375 ha/T2), Giurgiu (275 ha/T1,T2) and Târgoviște (225 ha/T1; 275 ha/T2). Nevertheless, after 2000, in relation to the industrial decline of some towns with negative consequences such as high unemployment rates, depopulation, population ageing etc. (Popescu, 2016), most of localities (mainly rural) recorded significantly lower built-up areas expansion (e.g. Suseni, Rătești, Drajna, Răcari, Posești, Boldești-Scăieni, Cotmeana, Câmpulung, Urlați).

Overall, the inner disparities between the northern and southern counties are maintained after 1990. The concentration of industrial activities in the northern counties (Argeș, Dâmbovița, Prahova) explains the general growth potential. On the hand, the least industrialized southern counties (Teleorman, Giurgiu, Ialomița, Călărași) (Popescu *et al.*, 2016) group the largest share of LAU with reduced or even no growth. However, throughout the entire Development Region, there is a very large number of localities in the plain or mountain areas where the prevalence of the agro-pastoral activities, the highest unemployment rates or the low accessibility limits the sprawling potential (e.g. Glodeni, Băleni, Adâncata, Viișoara, Ștefan cel Mare).

South-West Oltenia Development Region has an economy mainly based on agriculture and industry, but with a general low industrialisation level, which is concentrated in some of the important towns. The fluctuating economic development between 1990 until the early 2000s was substituted by a sustained recovery after 2007, the post EU accession period (Popescu *et al.*, 2016) which explains the differences in terms of built-up areas expansion potential between 1990–2000 (65,650; 38.1%) and 2000–2012 (35,000; 14.7%). Overall, built-up areas expansion is relatively high among all development regions (100,650 ha, 58.4%), mainly supported by some industrial towns which maintained their economic profile from the communist period: e.g. Râmnicu Vâlcea (525 ha/T1, T2), Craiova (400 ha/T1; 550 ha/T2), Slatina (250 ha/T1; 400 ha/T2), Drobeta-Turnu Severin (225 ha/T1; 325 ha/T2), supported by the revival of industry or other integrated production companies (e.g. *Prysmian Cables* and *Alro Slatina*, *Lafarge* Târgu Jiu, *Oltchim* Râmnicu Vâlcea). Craiova, in particular, maintains its position as growth pole due to its cultural and education role, but also due to the major investments in the already existing industries such as cars (e.g. *Automobile Ford* Craiova), aircraft and locomotive factories which have contributed to the revival of the regional economy (Bălțeanu *et al.*, 2016a). Also, higher growth is registered in Orșova, Novaci, Călimănești in relation to the touristic potential or in Bulzești, Bucovăț, Podari driven by the suburbanization processes (proximity to the city of Craiova) or the availability of land resources (arable land and pastures) for built-up areas expansion.

Generally, nearly 8% of LAU are subject to insignificant urban expansion (<50 ha). The main growth restrictions are related to the natural conditions (e.g. plain and tableland areas affected by extreme weather events; mountain areas characterised by high fragmentation, isolation and land degradation), low unemployment rate, population ageing, the collapse of industrial activity, poor accessibility to water and sewage systems etc. The southern half of the region (Oltenia Plain) is known as one of the most important agricultural regions in Romania. The major spatial and functional transformations of the post-communist period have turned the area into one of the most vulnerable to extreme weather phenomena (e.g. drought, heavy rainfall) leading to severe degradation of agricultural land with direct impact on crop production, human health, and rural welfare (Dumitrașcu *et al.*, 2018). Also, the poor accessibility to quality drinking water infrastructure (Mocanu *et al.*, 2011) constitute major limitations for the spatial development of most localities of Dolj (e.g. Apele Vii, Cârna) and Olt (e.g. Seaca, Urzica, Bucinișu) Counties. The northern half of the region is overlapping other restrictive areas susceptible to flood risk, mining activities (e.g. Motru–Rovinari Coal Basin) and land degradation (Cocherci, 2016) where some localities of Gorj (e.g. Glogova, Lelești) and Vâlcea (e.g. Șirineasa, Bunești) Counties are also subject to limited built-up areas expansion

West Development Region is among the most developed regions, ranking second in the regional hierarchy after the Bucharest–Ilfov Region, although there is a gap between the economic performance of two counties (Timiș and Arad) against the other two (Caraș-Severin and Hunedoara) (Popescu *et al.*, 2016). This could explain the intra-regional growth differences and the overall low built-up areas expansion after 1990 (744,150 ha; 46.1%) compared to the rest of Development Regions. Nonetheless, in terms of the distribution of growth shares between the two sub-intervals, the decreasing trend is maintained (490,450 ha; 33.8% in T1 and 253,700 ha; 13.1% in T2). Due to the concentration of most of industry and foreign investments in the counties of Timiș (telecommunications – *Alcatel Romania*, machine building – *Continental Automotive Products*, chemical – *Procter&Gamble*, electrotechnical – *Luxten Lighting Company*) and Arad (tradition industries – *Astra Wagons*, textiles *Teba*), significant built-up areas expansion occurred in the towns of Timișoara (325 ha/T1; 825 ha/T2) and Arad (900 ha/T1; 700 ha/T2). Here, the most important regional cluster of footwear industry is located, concentrating about one third of the footwear companies in the country (Bălțeanu *et al.*, 2016a; Popescu *et al.*, 2016). Thus, important growth is expected in the towns of Lugoj (250 ha/T1; 400 ha/T2) in Timiș County and Pecica (225 ha/T1; 375 ha/T2) in Arad County linked to the new foreign investments, development projects (e.g. *Lidl Logistic Center Lugoj*, *Arsat Pecica*) and modern transport infrastructure and accessibility. Also, particular increases in the metropolitan area of Timișoara in relation to the suburbanisation processes (e.g. Dumbrăvița, Moșnița Nouă, Sînandrei, Ghiroda, Dudeștii Noi) was also noticed. A large number of LAU registered significant built-up decrease or even no growth. The growth limitations are mainly related to the natural restrictions (e.g. relief fragmentation, altitude, accessibility) in the Banat Mountains (e.g. Lăpușnicu Mare, Șopotu Nou, Eftimie Murgu in Caraș-Severin County); the industrial decline of some mining sites or one-industry towns in Hunedoara (e.g. Brad, Petrila) and Caraș-Severin (e.g. Ocna de Fier, Ciudanovița, Oțelu Roșu) Counties (Dumitrescu, 2008); the collapse of some popular touristic resorts (e.g. Băile Herculane in Caraș-Severin County); the dominate agricultural activities in Banat Plain (e.g. Pesac and Pădureni in Timiș County, Peregu Mare and Șeitin in Arad County).

6. DISCUSSIONS AND CONCLUSIONS

Among the traits of urban growth associated with sprawl are the outward built-up areas expansion, low-density housing and commercial development, leapfrog development, “edgeless” cities, fragmentation of land use planning among multiple municipalities, reliance on private automobiles for transportation, segregation of types of land use class-based elitist housing, congestion and environmental damage (Squires, 2002). Over the last years, cities occupy increasingly more space mainly invading arable land, pastures, permanent crops and agricultural complex cultivation patterns. As a consequence, urban expansion through low-density and scattered suburban development (urban sprawl) involves a wide variety of environmental and socio-economic consequences (e.g. traffic congestion, air pollution, social segregation). However, the extension of urban space does provide benefits, allowing people more living space, single-family houses and gardens (EEA, 2010). The low-density characteristic of such development provides ease of commuting and access to shopping for those who live and work in selected suburban areas. It may also provide a separation from the city life associated problems (e.g. unemployment, poverty) (Squires, 2002).

In Romania, under the political, institutional and socio-economic conditions of the post-communist period, significant land use/cover changes occurred, built-up areas being the most dynamic land use category. As a result, urban growth-related spatial transformations become extended. Differences, however, are noticed between the two analysed intervals in relation to the particular social and economic transformations of the transition (1990–2000) and post-transition (2000–2012) periods. Also, the specific environmental features of each Development Region have led to significant inter- and intra-regional disparities. North-West Development Region had experienced the largest share of

built-up areas expansion (60.8%) mainly in relation to the extended suburbanization processes in the proximity of large and medium-sized towns (e.g. Cluj-Napoca, Satu Mare, Baia Mare, Bistriţa), the renewal of former industrial sites, new foreign investments in industry and services, as well as the availability of land resources to be converted to built-up areas. The lowest share of urban expansion (45.1%) was recorded by the South-East Development Region, which, although holds some important large towns with national-level industrial and services functions (e.g. Constanţa, Galaţi, Brăila), also includes large rural-agricultural (e.g. eastern part of Romanian Plain, Dobrogea Plateau) and natural restrictions (e.g. waters and inland marshes in the Danube Delta) areas with low accessibility to transportation and services, population aging and high unemployment rates. A particular case is of Bucharest–Ilfov Development Region, which, although the smallest in size (the city of Bucharest and Ilfov County) had experienced a significant urban growth share (53.3%) mainly driven and under the influence of the capital-city and the expended suburbanization processes which are taking place quite constantly after 1990 in Ilfov County.

Generally, urban growth has been mainly observed in the proximity of the main cities (e.g. Bucharest, Constanţa, Sibiu, Iaşi, Oradea, Hunedoara, Cluj-Napoca, Târgu Mureş, Ploieşti, Buzău, Craiova, Piteşti) at the expense of arable lands, pastures and agricultural complex cultivation patterns. On the other hand, rural areas with limited socio-economic conditions, low accessibility, social inequalities, and, above all, exposed to extreme natural phenomena where subject to lower built-up areas dynamics, thus limited urban growth.

Urban-growth related studies are aimed at providing important data on the detection and measurement of the sprawling process in terms of location, spatial extension, patterns and scale. The assessment of the relationships between land use/cover change and urban growth process is also an important component of urban development. This enables the complex evaluation of urban sprawl in order used in the planning processes by decision-makers and local communities, as well as for spatial modelling to support future growth and to develop planning scenarios.

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