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Article

Dynamics of Urban Systems in Relation to Land-Use Changes in the North East Development Region of Romania

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Abstract. Spontaneous urban development, specific to East European cities in the post-socialist period, produces permanent land-use changes. The study aims at analyzing this phenomenon for the particular case of the North East Development Region of Romania. Although as a way of manifestation there are many similarities at regional level, the behavior of urban systems and land-use changes are influenced by many local factors. For this study, updated data provided by Corine Land Cover were capitalized, and the analysis were carried out in temporal stages – 1990 – 2000 – 2006 – 2012 – 2018 using the ArcGis software. In terms of assessing the consequences of urban development, the analysis concentrates on permanent changes that can indicate the penetration of urban space in rural areas. The largest area of land-use category transformed into artificial surfaces belongs to the agricultural sector. The challenge is to analyze the magnitude of this phenomenon, the main consequence being the consumption of productive land, and to see if its perpetuation and intensification contravenes the principles of sustainable development.

Keywords: urban systems, urban development, urban sprawl, land-use changes, post-socialist period, regional development.

Resume. Le développement urbain spontané, propre aux villes d'Europe de l'Est dans la période postsocialiste, produit des changements permanents d'occupation des sols. L'étude vise à analyser ce phénomène au niveau régional, sur les surfaces de la Région de Développement du Nord-Est de la Roumanie. Malgré les similitudes dans sa manifestation qui existent au niveau régional, le comportement des systèmes urbains et les changements d'occupation des sols sont influencés par de nombreux facteurs locaux. Pour cette étude, ont été capitalisées les données mises à jour et fournies par Corine Land Cover, l'analyse étant réalisée par étapes temporelles - 1990 - 2000 - 2006 - 2012 - 2018 à l'aide du logiciel ArcGis. En termes d'évaluation des conséquences du développement urbain, l'analyse se penche sur les changements permanents

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qui peuvent indiquer la pénétration de l'espace urbain dans les zones rurales. La catégorie d'occupation des sols dont la plus grande surface a été artificialisée appartient au secteur agricole. L'enjeu est d'analyser l'ampleur de ce phénomène, dont la principale conséquence est la consommation de terres productives, et de voir si sa perpétuation et son intensification contrevient aux principes du développement durable.

Mots-clés: systèmes urbains, développement urbain, étalement urbain, changements d'occupation des sols, période postsocialiste, développement régional.

1. Introduction

Land-use changes represent a subject of analysis and discussion for many researchers, especially when it comes to restructuring land use patterns under the pressure of urbanization and associated phenomena. In the East European context, the urban development phenomenon of post-socialist cities has a specific manifestation form, known as urban sprawl. The effects and consequences of this phenomenon make the study of spatial and temporal changes in land use an important and up to date issue (Dadashpoor et al., 2019).

Land-use changes are analyzed at various scales of detail, researchers choosing as study areas, larger areas, treating the phenomenon at country level (Kucsicsa et al., 2019; Kuemmerle et al., 2009; Bălteanu and Popovici, 2010); and regional level (Hegazy and Kaloop, 2015; Betru et al., 2019; Ursu et al., 2007; Salvati et al., 2012; Stefanski et al., 2014) or smaller areas that allow a more detailed analysis, such as metropolitan areas (Dadashpoor et al., 2019; Hegazy and Kaloop, 2015; Tomașciuc et al., 2016) and cities (Hewitt and Escobar, 2017). From a methodological point of view and the data used, researchers prefer either the analysis on satellite images (Dadashpoor et al., 2019; Kuemmerle et al., 2009; Betru et al., 2019), or use the multi-temporal vector data provided by Corine Land Cover (Kucsicsa et al., 2019; Bălteanu and Popovici, 2010; Tomașciuc et al., 2015; Hewitt and Escobar, 2017) for spatial analysis of the phenomenon. For this paper, Corine Land Cover data has been used for multiple years (1990, 2000, 2006, 2018).

Urbanization is the process that causes the most land-use changes, principally the urban sprawl phenomenon (Kucsicsa et al., 2019). In terms of landscape, urban expansion leads to fragmentation and reduces aggregation at territorial level (Dadashpoor et al., 2019), especially when it comes to spontaneous, unplanned expansion. Urban dynamics, manifested through territorial expansion (often by expanding into rural settlements in the vicinity), produce effects visibile through land-use changes, mainly in metropolitan areas and in areas close to large cities (Figure 1). The way we can understand landscape changes and their reactions is to analyze the dynamics of the land-use pattern (Dadashpoor et al., 2019).

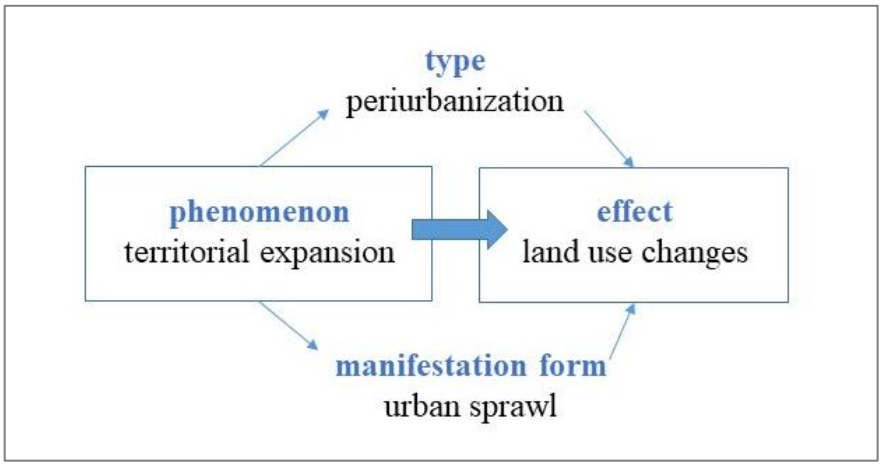


Figure 1. The characteristics of spontaneous territorial expansion

At the level of Romania, during the post-communist period there were many land-use changes on the background of socio-economic political and institutional changes (Kucsicsa et al., 2019). There are several studies that analyze this phenomenon at a national scale (Kucsicsa et al., 2019; Bălteanu and Popovici, 2010; Petrișor, 2012; Grigorescu et al., 2012), regional (Kuemmerle et al., 2009; Ursu et al., 2007) or at metropolitan area level (Simion, 2010; Tomașciuc et al., 2015; Tomașciuc et al., 2016). The trigger factors for land-use changes differ from one development region to another (Kucsicsa et al., 2019), the main factors involved in these changes being political, economic, technological, demographic, and sometimes even natural factors (Bălteanu and Popovici, 2010) or specific local conditions. The study made by Grigorescu et al., 2012 indicates a stronger connection between socio-political factors and land-use changes compared to natural factors. According to Kucsicsa et al., 2019, the most important socio-economic factors that influence land-use changes are the density of secondary roads, the density of dwellings and the distance to the first main road.

Land-use changes may be temporary, being reversible (eg. arable land to pasture) or permanent, being irreversible (eg. agricultural land to artificial areas), which also have a greater impact on the environment (Ursu et al., 2007). Taking into consideration that this paper assesses the relation between urban expansion and land-use changes, this work concentrates on the permanent changes.

The general purpose of analyzing land-use changes from the perspective of urban dynamics is to provide the necessary support for sustainable planning (Dadashpoor et al., 2019), understanding the magnitude and direction of the phenomenon being important (Betru et al., 2019). Land-use changes should be considered as central components for natural resource management and environmental monitoring strategies (Hegazy and Kaloop, 2015). The specific purpose of this paper is to analyze how urban dynamics influenced land-use

changes, having as a study area The North East Development Region and as a reporting period, the post-communist period.

2. Study area: general features

In Romania, the regional development policy emerged from the need to correct the existing regional disparities after the socialist period and align with the main regionalization tendencies. According to the Law no. 151/1998, in Romania are constituted the development regions that were based on *the criterion of functional-potential integration*, 8 regions being established around the polarizing centers (Antonescu, 2016).

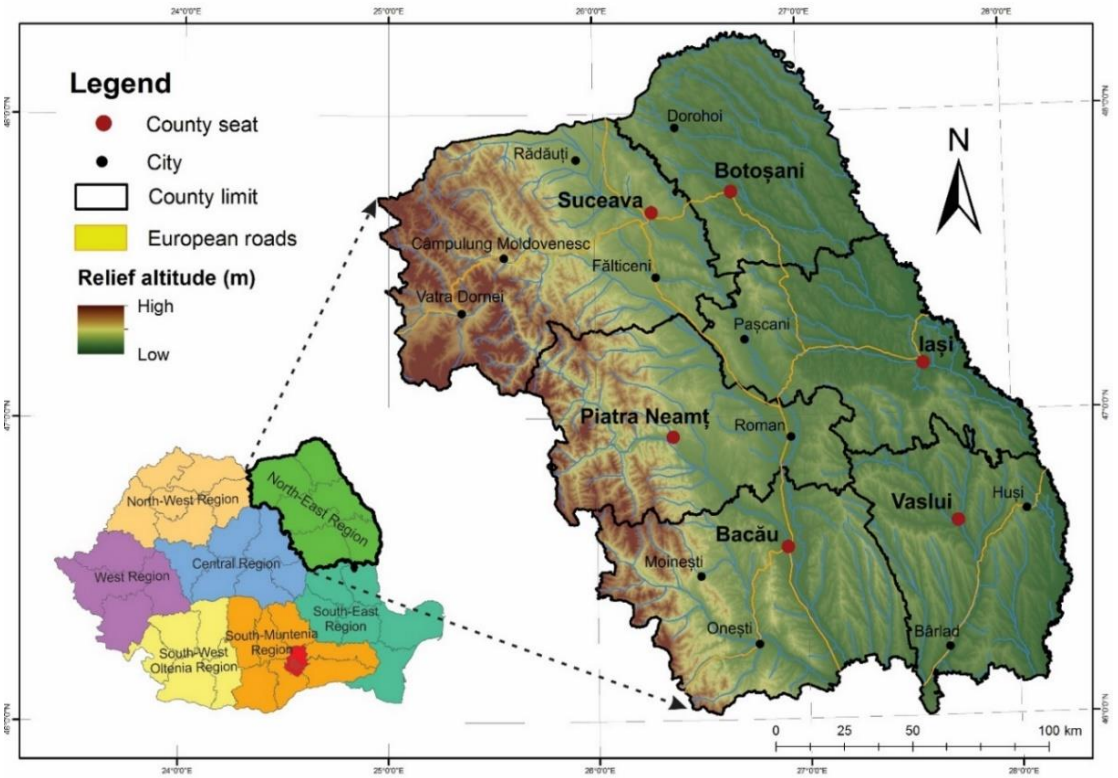


Figure 2. Geographical location of North East Development Region of Romania

The present study concentrates on the analysis of permanent land-use changes in the post-socialist period for the North East Development Region, consisting of 6 counties: Suceava, Botoșani, Neamț, Iași, Bacău and Vaslui. In terms of inhabitant number, the most important urban systems are the municipalities of Iași, Bacău and Botoșani (with over 100.000 inhabitants), followed by 5 medium-sized cities such as Suceava, Piatra Neamț, Bârlad, Vaslui and Roman (50.000 – 100.000 inhabitants) (Figure 2).

With the Government Decision no. 998/2008 the policy of growth poles was initiated, whereby it is proposed to induce a rapid economic growth and jobs creation at the level of Romania. Thus, in the northeast, Iași was designated the growth pole and the municipalities of Bacău and Suceava – development poles (North East Regional Development Plan 2014-2020).

According to data provided by the National Institute of Statistics regarding the population by permanent residence, at the level of 2019, The North East Development Region numbers 3.302.000 people, being the region with the highest number in terms of population, with a demographic growth of 106.981 persons from 1992 and with the largest surface from Romania, but being in the last place in terms of development.

3. Data and methods

The territorial expansion and land-use changes were identified and interpreted from multiple spatial data sets using the ArcGis software. The land-use for the years 1990 – 2000 – 2006 – 2012 – 2018 and the vector files with the changes that occurred between these intervals were extracted from Corine Land Cover data. Following the evolution of each class, some problems have been identified, some data losing consistency (they do not have continuity). This can be attributed to the quality of the images used for mapping, because the more recent satellite images are better than the old ones in terms of resolution, allowing the correction of some previous errors, but also the fact that some of the data provided have not been fully validated yet (such as data for 2018). For this reason, in addition to data extracted from Corine Land Cover we also used for interpretation multi-temporal orthophotoplans from google earth pro and previous studies reported to Romania or to certain regions of the country. For the graphical representation of the evolution of the built-up space, the classes representing the built-up space were extracted from Corine Land Cover for the years 1990 and 2018, this representation being doubled, for more accuracy, by the evolution of the housing stock for the years 1990-2017 (using data provided by the National Institute of Statistics). The graphs presented in the paper were created with data extracted from the attribute tables of ArcGis database.

4. Results and discussions

4.1. The dynamics of urban systems in The North East Development Region – *urban sprawl*

According to the literature, the phenomenon of urban sprawl is a multidimensional topic (Arribas-Bel, et al., 2011), being a process that has similar characteristics worldwide, being caused by comparable social and economic issues (Siedentop, Fina,

2012). In many cases, especially for large-scale urban systems, urban sprawl is perceived as a negative phenomenon, with a bad impact on the environment (Johnson, 2001; Terzi, Bolen, 2009; Torres et al. 2007). At European level, the space per person in cities has doubled in the last 50 years and the built-up space has increased in many countries by 20%, while the population has grown by only 6% (EEA, 2006; Suditu et al., 2010). A peculiarity of the phenomenon of periurbanization at national level is represented by the exaggerated surface of the newly built dwellings, notably the dwellings financed by the emigrant population.

Romania's integration in the European Union has accelerated this process, the new interfaces occurred at the contact area of the big cities with the surrounding communities being accentuated (Ianoș et al. 2010). At national level, the periurban spaces are the most dynamic in terms of territorial expansion and population growth, the main cause being the migration of the population from nearby urban areas (Tomașciuc et al., 2015). After 1990, the main political dimensions that generated the installation of the periurbanization process, nonexistent in the communist period, were the appearance of private property and property restitution, the freedom to settle in any environment, the high level of corruption and the lack of specific legislative and urban regulations. Land Fund Law no. 18/1991 represented a first step in the restitution of properties, being the first to have major effects on land use after the communist period. By this law, the right of private ownership was established for the land belonging to the patrimony of the Agricultural Cooperatives of Production. Thus, members who brought land to Agricultural Cooperatives or their heirs were, upon request, attributed the property title. The transition from communal exploitation during communism to small family exploitation in the post-socialist era had as a major consequence the excessive fragmentation of the land, followed by a chaotic development of space.

In order to analyze the territorial expansion in The North East Development Region, the attention was centered on the county seat cities. The map representing the expansion of the built-up space (Figure 3) was made by extracting the classes corresponding to the built-up space from Corine Land Cover data for the years 1990 and 2018. The accuracy of data may be slightly affected by the fact that the Corine Land Cover data for 2018 was recently published and has not been fully validated and also by the fact that only the changes with a surface area of minimum 5 hectares were taken into account when mapping the layers for Corine Land Cover (the map is made on a scale of 1:100.000, the degree of generalization being quite large). In the context of spontaneous, diffuse expansion, many of the newly built surfaces are dissipated, not forming compact areas with a minimum area of 5 hectares.

Most of the changes are visible on the map in areas located in the outskirts of the cities, but also on the territory of rural localities from the proximity. The way of manifestation of the territorial expansion, namely the orientation towards individual

dwellings, reflects a change in the mentality of the population, regarding the improvement of the quality of the living environment and comfort. Due to the fact that many communal dwellings inherited from the communist period had a low degree of comfort, after 1990, the natural reaction of the population was to improve living conditions through migration to periurban areas, where they had the possibility to build individual houses, with larger space and increased comfort. The main drivers of change in attitudes and perceptions of people and implicitly of lifestyle (alongside political transformations) are: globalization, the emergence of multinationals and the access of population to information through media and internet.

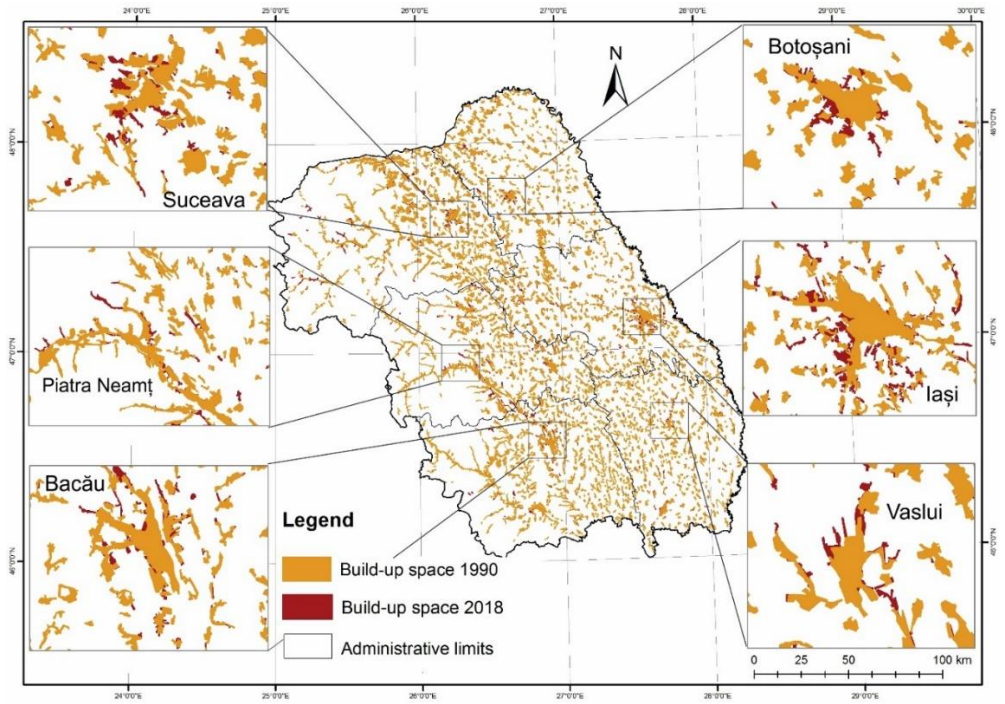


Figure 3. Built-up space expansion between 1990 – 2018, in The North East Development Region, *using data provided by Corine Land Cover Data*

In order to better outline the phenomenon of periurbanization materialized through the penetration of the built-up space in the neighboring communes of the big cities, the evolution of the housing stock was graphically represented, for the county seats and the communes located in the first two rings around them, using data provided by the National Institute of Statistics (Figure 4).

Thus, it can be noticed that Iași is the city that has expanded most in the nearby communes, being also the largest city in the region and the attraction pole for the entire region of Moldova. The communes (Miroslava, Valea Lupului, Bârnova,

Ciurea, Aroneanu) which have the higher expansion of the housing stock in the last decades, are located in the first ring in the proximity of the city. A representative example is the case of Miroslava commune, situated on the south-western border of Iași (Figure 5), which has increased its housing stock from 1.743 in 1990 to 7.697 in 2017, with an expansion of over 300%, the process being accelerated after 2006.

According to figure 4, the city of Iași is followed, in terms of territorial development model, by the cities of Bacău and Suceava, one of the most important factors of influence being the economic development of these regions. In Bacău, urban expansion is limited by natural and infrastructure barriers, but also by the proximity of rural settlements (Bănică and Picioruș, 2012).

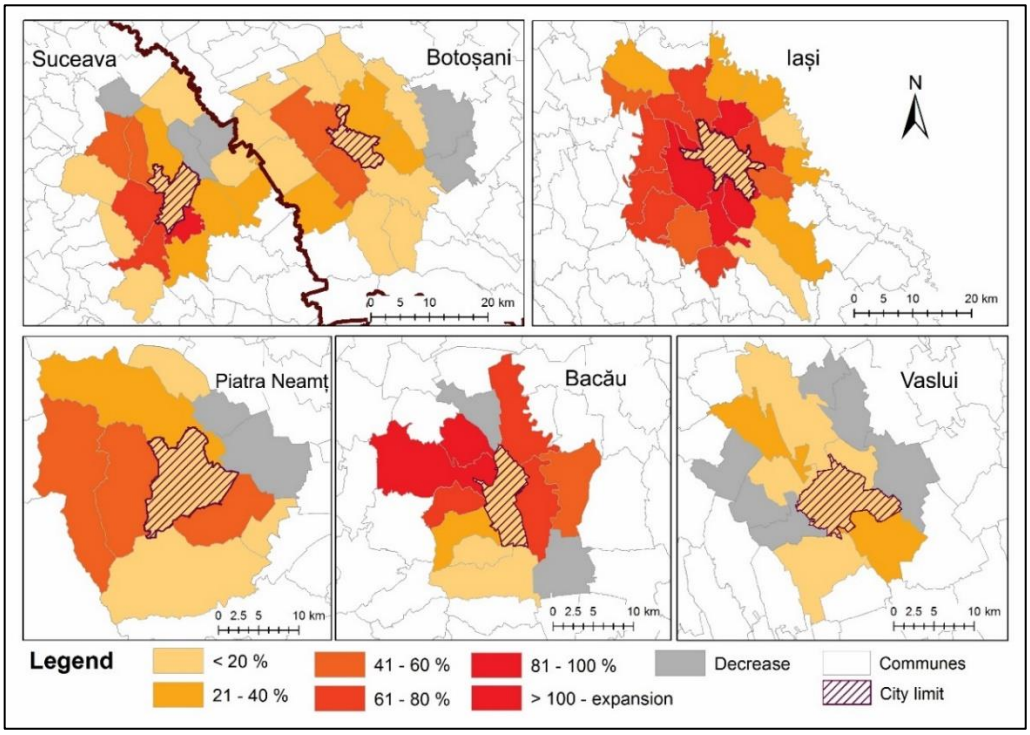


Figure 4. The evolution of housing fund in the main cities from The North East Development region (in the county residences) and in the communes located in their proximity, *using data provided by National Statistics Institute*

In the case of Suceava Municipality, the expansion of the housing stock has expanded beyond the administrative boundaries of the city, in the neighboring communes, pointing out in this regard the communes of Șcheia, Ipotești and Moara located in SW, SE and S towards Suceava. According to statistical data, the periurbanization phenomenon, although existing, is less visible in the proximity of Vaslui and Piatra Neamț.

Figure 5. Built-up space expansion in Miroslava, Iași; orthophotoplans 2003, 2018 *extracted from Google Earth Pro*

4.2. Land-use changes in relation to urban expansion in The North East Development Region

One of the main factors generating land-use changes are human activities. The land is currently one of the most valuable natural resources available (Hegazy and Kaloop, 2015), and the diffuse territorial expansion is very land consuming, because apart from the actual occupation of the land, it also fragmentates it very much. Thus, permanent land-use changes, emphasize the impact of urban development on the areas located in communes in the vicinity of cities.

Figure 6 presents the permanent land-use changes, respectively the categories of land-use that were transformed into artificial spaces between 1990 and 2018 in the six county seat cities and in the communes situated in the adjacent area. One of the main problems created by land-use changes is the loss of agricultural land and forests in favor of artificial spaces.

Most of the land-use categories that were the subject of change are part of the agricultural sector (arable land, permanent crops, pastures, heterogeneous agricultural areas), and of the 2.361 ha identified, almost half (1.088 ha) are arable lands, the largest loss of agricultural land being recorded in the vicinity of Iași (1.065 ha) and Suceava (443 ha), followed by Bacău (325 ha) and Botoșani (284 ha). According to the data obtained from Corine Land Cover, the areas with the lowest loss of agricultural land for built-up space are located in the proximity of Vaslui (40 ha) and Piatra Neamț (190 ha).

Analyzing the land-use changes map (Figure 7), it can be seen the link between urban expansion and the areas that are subject of change, which overlap considerably over the directions of urban territorial expansion. Although the trends are visible and accurate, the quantitative data obtained from the analysis of data provided by Corine Land Cover indicates a number of relevant results but diminished versus the real situation in the field. As mentioned in the methodology, the degree of generalization

of the data provided by Corine Land Cover is very high due to the scale of the map, and the territorial expansion is very diffused and fragmented. For this reason, the small areas are not visible either on graphic representations or in quantitative data. According to the map, the most changes are identified in Iași, Suceava, Botoșani and Bacău.

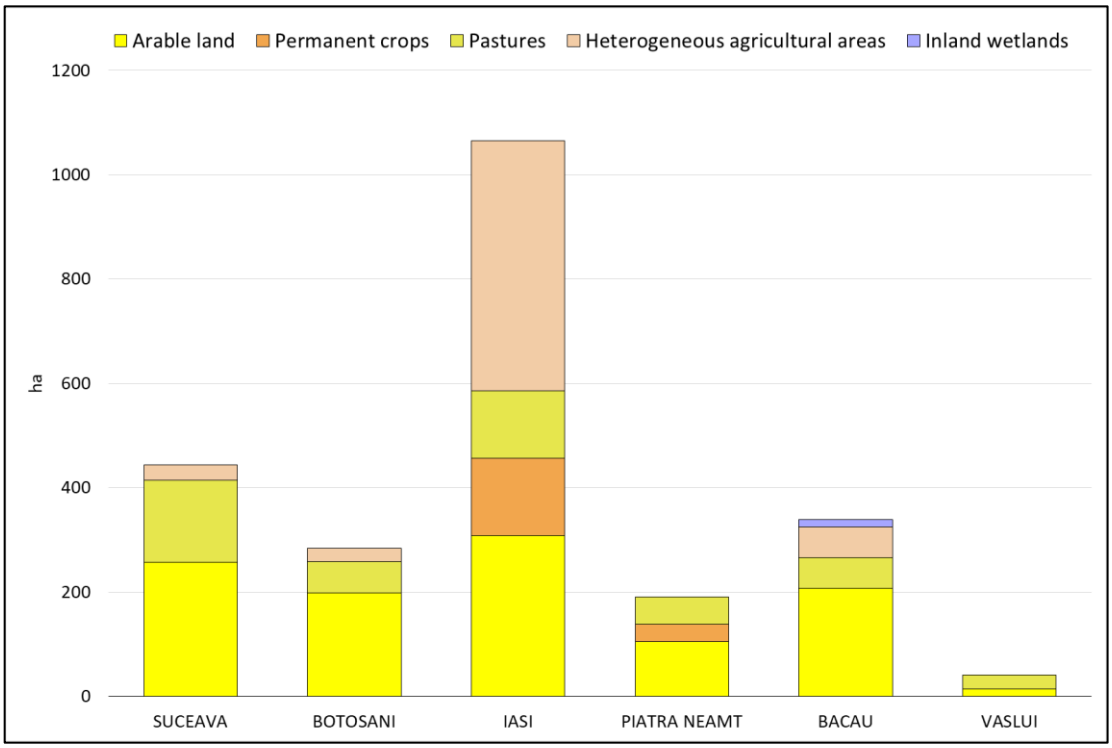


Figure 6. Permanent land-use changes 1990-2018 (surface of land-use categories transformed in artificial spaces, in the county residence cities), *Corine Land Cover data*

The period 1990 – 2000 is considered a period of transition, with slower urban expansion and consequently the surface of agricultural land converted into built-up area is more limited. Since 2000, but more visible after 2006, there has been a much higher frequency of areas transformed into artificial spaces (Tomașciuc et al., 2015). Another explanation for the fact that by the year 2000 the urban sprawl phenomenon (and consequently the land-use changes associated with it) was less present is the fact that the transition from outside built-up area to urban area was difficult and expensive. After 2000, the passage from outside built-up area to urban area was facilitated without incurring very high costs, and consequently the phenomenon of territorial expansion began to increase, especially at the contact between the urban space and the rural area.

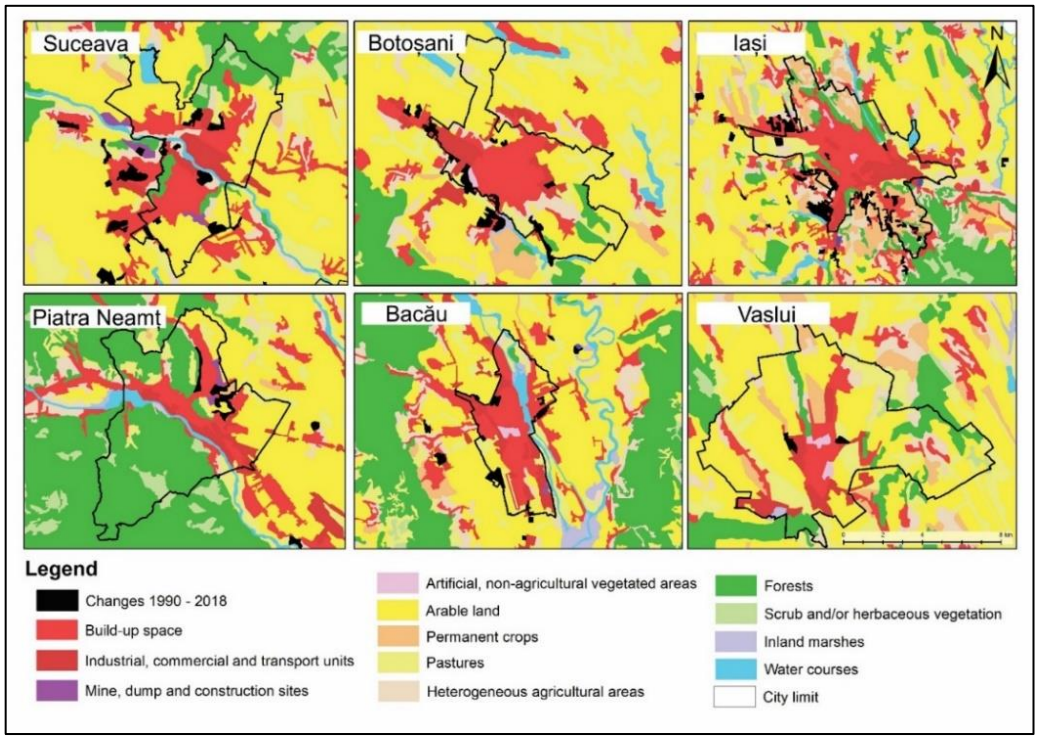
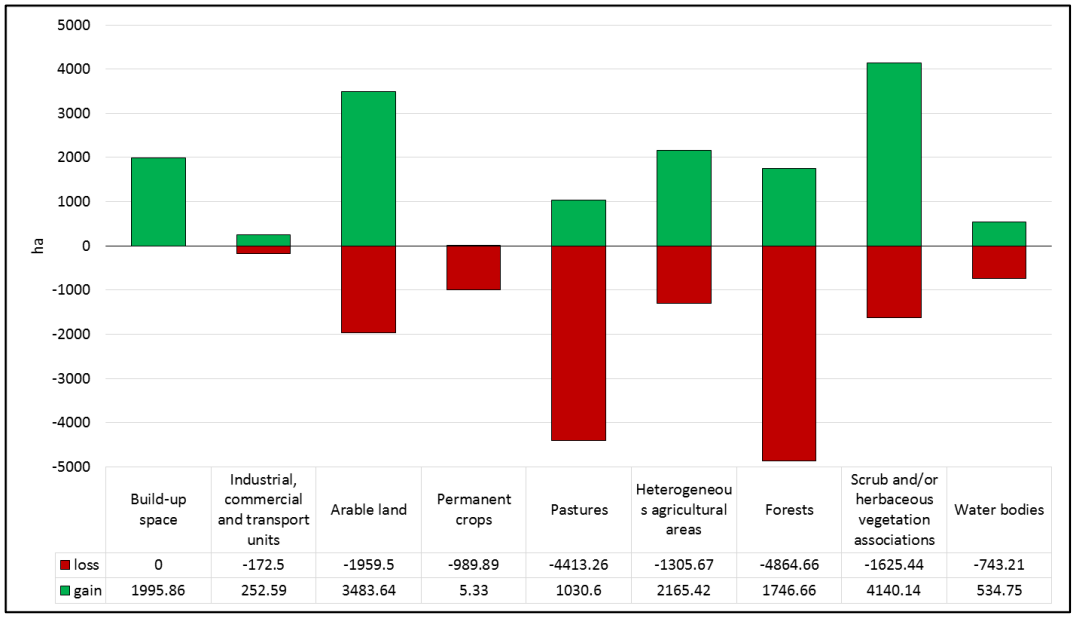


Figure 7. Land use and land use changes in the main cities from the Northeast Development region; *Data source: Corine Land Cover 1990 – 2018*



	Build-up space	Industrial, commercial and transport units	Arable land	Permanent crops	Pastures	Heterogeneous agricultural areas	Forests	Scrub and/or herbaceous vegetation associations	Water bodies
loss	0	-172.5	-1959.5	-989.89	-4413.26	-1305.67	-4864.66	-1625.44	-743.21
gain	1995.86	252.59	3483.64	5.33	1030.6	2165.42	1746.66	4140.14	534.75

Figure 8. Land-use change between 1990 – 2018 (gain and loss)

The evolution of land-use changes has been made using the same boundaries of county residences and neighboring communes. Thus, the built-up area has expanded over the last 30 years with more than 1990 ha, mostly on agricultural land (Figure 8). However, by analyzing the changes and the related chart, it has been identified that built-up area has expanded on arable land and the arable land has spread on pastures to cover the need of productive land.

The land-use classes for which the land losses are higher than the gains are represented by pastures (4.413 ha losses and only 1.030 ha of new lands transformed) and forests (4.864 ha, mainly being affected the deciduous forests), being correlated with the deforested areas of 4.140 ha. The one class that has only a negative trend belongs to the category of vineyards and orchards (about 1.000 ha – of which 700 ha refer to orchards).

Conclusions

Land-use changes are one of the drivers of global change of the environment and should therefore occupy a central place in the discussions regarding the sustainable development (Hegazy and Kaloop, 2015).

The evolution of cities belonging to the former communist bloc presents more similarities to the development model of North American cities at the expense of urban dynamic characteristic for Western European cities (Stanilov, 2007).

At the level of Romania, there have been several studies on land-use changes and urban sprawl, both at national level and at regional level. Analyzing the results indicated in these papers, we can mention that the North East Development Region is largely in line with the country-wide general trend regarding permanent land-use changes.

The most widespread permanent changes are those from areas that are part of the agricultural sector in artificial spaces, and the most of these are arable lands. The main engine that generates these changes is urban sprawl, which is not considered to be sustainable because of its large space consumption due to its diffuse character, the lack of pre-development planning that generates certain shortcomings and problems in terms of infrastructure (poor road quality, lack of sidewalks), accessibility (personal car dependence), access to utilities (often water supply, electricity, etc. networks are under-dimensioned and fail to keep up with the high degree of expansion in some areas), the discomfort created by the dynamics of these areas (there are permanent construction works).

Urban sprawl / land-use changes and sustainable development contradictions:

- Urban sprawl affects travel behavior by increasing the number of people who have to use their personal car – environmental issue: decrease of air quality.

• Loss of natural and arable land – environmental issue: affects natural habitats and ecosystems; loss of farmlands.

• Exaggerated surface of newly built dwellings, requiring higher maintenance costs and higher energy consumption for heating / cooling the house – environmental issue: increase of consumption.

• The local landscape is often affected by the storage of waste resulting from intensive construction works (dwellings, roads/infrastructure) – environmental issue: soil and water pollution.

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No potential conflict of interest was reported by the authors.

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