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POST-COMMUNIST LAND COVER AND USE CHANGES IN ROMANIAN BANAT, BASED ON CORINE LAND COVER DATA

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Abstract: *Land cover and land use change is a topical global issue and an obvious process in the landscape of the ex-communist states, including Romania. After the change of political regime in the 1990s, political, economic, technological and demographic factors became mainly responsible for changes in land use. The main objective of the present study is to inventory all these changes in one of the most developed regions of Romania, a multi-ethnic and multicultural region - Romanian Banat, which encompasses all the relief levels of the country. For this purpose we have turned to one of the most widely used tools for the analysis of land dynamics at European level, namely the CORINE Land Cover Database. A comparative analysis between the transition period (1990-2000) and the post-transition period (2000-2018) was therefore carried out, with CORINE Land Cover data grouped into 7 transitional dynamics: urbanization/industrialization, development of agriculture, abandonment of agriculture, deforestation, afforestation, floods and others. The results revealed for the Romanian Banat more intense changes in the post-transition period, concentrated in 14 hotspots overlapping the relief units. Most intensely affected by changes have been the hilly areas, depressions and valley corridors, dominated by abandonment of agriculture and deforestation, followed by lowland areas where development of agriculture and urbanization are visible in the landscape. Mountain areas show the least change in this region, being largely overlain by protected areas.*

Key words: *land use change, CORINE Land Cover, transitional dynamics, post-communist period, Romanian Banat*

1. INTRODUCTION

The analysis of Land Cover and Land Use (LCLU) change is important in the context of debates on sustainability (Lambin et al., 2000), biodiversity conservation (Ojima et al., 1994, Poschlod et al., 2005), monitoring of degraded land (Foley et al., 2005). In the Central and Eastern European countries, changes in LCLU have been mainly influenced by changing land management practices and policies in the post-socialist period (Van Dijk , 2003; Hostert et al., 2008; Václavík and Rogan, 2009; Hartvigsen, 2014; Bański, 2018). Following the decollectivization and privatization processes started after 1990s and the different strategies for implementing land reforms, there was an expansion of private ownership of agricultural and forest land (Bălteanu & Popovici, 2010; Bański, 2018; Mihalache, 2018; Ianoș & Secăreanu, 2020), leading in many cases to the abandonment of cultivated land (Kuemmerle et al., 2009; Muller et al. 2009), deforestation (Dutcă & Abrudan, 2010; Petrișor et al., 2020), as well as significant reduction in the areas occupied by the upper and profitable land categories (vineyards and orchards) in favor of the less profitable ones (pastures and meadows) (Bălteanu & Popovici, 2010), degradation of land quality etc.

The fall of the communist regime also brought significant changes in Romania's land cover categories, leading to numerous conversions from one category to another. The studies conducted on the dynamics of LCLU categories have highlighted a number of phenomena, some antagonistic, namely: abandonment of agriculture vs development of agriculture, deforestation vs afforestation, urbanization (Bălteanu & Popovici, 2010; Dutcă & Abrudan, 2010; Grigorescu et al. 2012; Petrișor et al., 2020). After the 1990s, following the implementation of numerous land measures (Aligică & Dabu, 2003), the agricultural sector became dominated by small, self-sufficient and isolated family farms (Otiman, 1997; Hartvigsen, 2014), with most of the new owners being elderly and financially weak (Bălteanu & Popovici 2010). In this context, many previously cultivated lands have been abandoned, converting in most cases to pastures (Kuemmerle et al. 2009) or to natural afforestation (Dutcă & Abrudan, 2010). Agriculture developed after the 2000s with the advent of land consolidation following land purchase or lease, and especially after the 2007s, with Romania's accession to the European Union and the consolidation of the role of large land holdings through land purchases by companies with Romanian and foreign capital (Mihalache, 2018), but also through EU funding that encouraged forms of association (Ianoș & Secăreanu, 2020). Land restitution after the 1990s created a favorable context for illegal logging, but also for afforestation through conversion from other types of land use to forest, through plantations or natural regeneration (Dutcă & Abrudan, 2010).

The phenomenon of urbanization is a process directly related to the concentration of population in large cities, influencing mainly the agricultural land in their vicinity, which, following urban expansion, has been transformed into other categories of land use (residential projects, commercial, warehouses and industrial units), (Petrișor et al., 2010; Grigorescu et al., 2012; Petrișor, 2012; Ianoș et al., 2016). In the context of socio-economic and political transformations after the 1990s, the present study aims to analyze the changes that occurred in the period 1990 - 2018 in the LCLU categories from Romanian Banat and to identify the areas with the highest dynamics of these changes, using CORINE Land Cover data. Many similar studies have been carried out in Romania, analyzing changes in LCLU after the 1990s, using the

same database (Popovici et al., 2013; Petrișor et al., 2012, 2015, 2017, 2018, 2020; Hanganu & Constantinescu, 2015; Kucsicsa et al., 2019; Rusu et al., 2020), but most of them focused on the national territory or on the development regions of Romania. The present study proposes an approach at regional level, the analysis of LCLU changes being carried out at relief unit level, thus bringing original contributions to studies in Romania, but also in Central and Eastern European countries.

2. STUDY AREA

Situated in the South-Western part of Romania, the Banat region is a well-defined territorial unit within the country, whose historical evolution has left its mark on the organisation and subsequent development of this area. This territory corresponds to the largest part of the historical province of Banat (about 2/3 of the total area of 28526 km²), stretching from the Carpathian Mountains in the East to the Tisa River in the West, including within these boundaries a ″Serbian Banat″, which overlaps the autonomous region of Voivodina (almost 1/3), and a small territory at the mouth of the Mureș River in the Tisa River (284 km²), which belongs to Hungary (Popa et al., 2007). The boundaries of the Romanian Banat (see Figure 1A) are marked by physical-geographical discontinuities to the North and South, namely the Mureș River from Zam to the Hungarian border and the Danube Valley from Baziaș to Vârciorova, by a conventional Western boundary, constituted by the border with Serbia, and by a natural boundary, less individualized in the landscape represented by the Mehedinți Mountains, Cerna Valley, the main ridge of Godeanu Mountains, Poiana Ruscă Mountains (Creţan, 1999; Ancuța, 2008). Between these limits, the Romanian Banat comprises the entire territory of two counties: Timiș and Caraș- Severin, together with 12 administrative-territorial units in Arad county and 4 administrative-territorial units in Mehedinți county (see Figure 1B). Its geographical position at the interface of three major physical-geographical regions (South-European, East-European and Central-European) has played an important role in the identification of the main features of the natural environment. The great variety of relief, the moderate climate, the diversity of flora, fauna and soil cover played a special role in structuring the geographical space of Romanian Banat. The favorable and complex conditions of the region allowed the intensification of anthropization over time, as the capacity of communities to take advantage of the multiple potentials offered has increased (Ancuța, 2008). The relief is characterized by a great complexity of morphological forms: from subsidence plains (70-80 m altitude), piedmont plains (110-180 m), low hills, low mountains and up to high mountains with altitudes of over 2000 m in the South-Eastern extremity of the region (see Figure 2), determining a great diversity of land cover categories and land use patterns (Creţan, 1999). They are arranged in an amphitheater shape, opening towards the West.

The mountains occupy an extensive area, their petrographic nature, geological structure and tectonics imprinting a suite of regional differentiations (Velcea & Savu, 1982). The Banat Mountains and the high mountain massifs forming the Western extremity of the Southern Carpathians, occupy the largest part of Caraș-Severin County (about 65%). The Western slopes of the Poiana Ruscă Mountains extend into the Eastern part of Timiș County. The mountain area is characterised by a wide spread of forests, meadows and pastures, important subsoil resources and water resources. The mountain units are separated by a series of depressions and valley corridors (Almăj

Depression, Caraș-Ezeriș Depression, Caransebeș Depression, Bistra Valley, Mehadica Depression, Cerna Valley, etc) which introduce a special landscape note into the mountain ensemble, through the presence of human settlements and specific land use patterns.

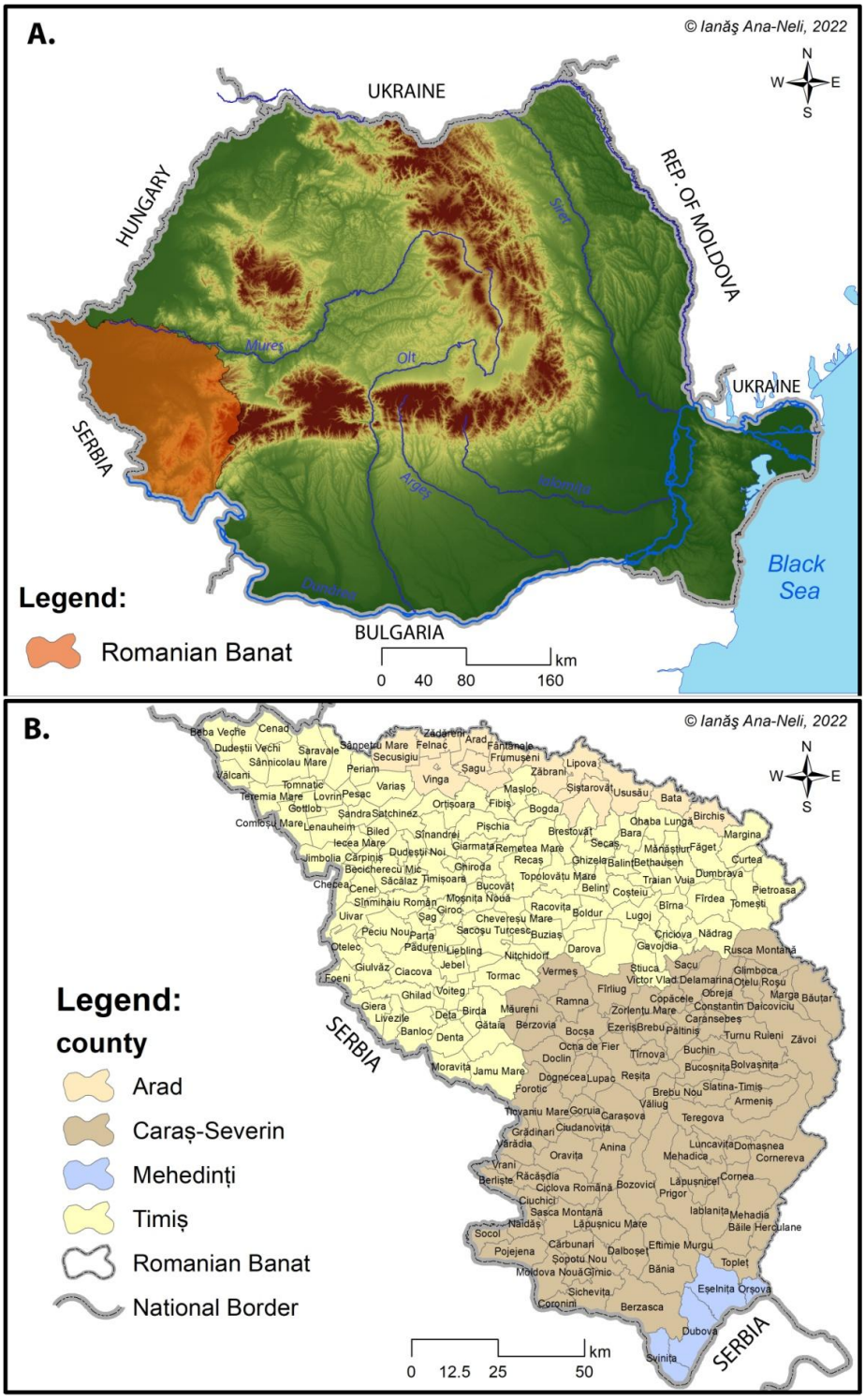

Figure 1. Romanian Banat limits
(A. Localion and natural limits; **B.** Administrative-territorial units)

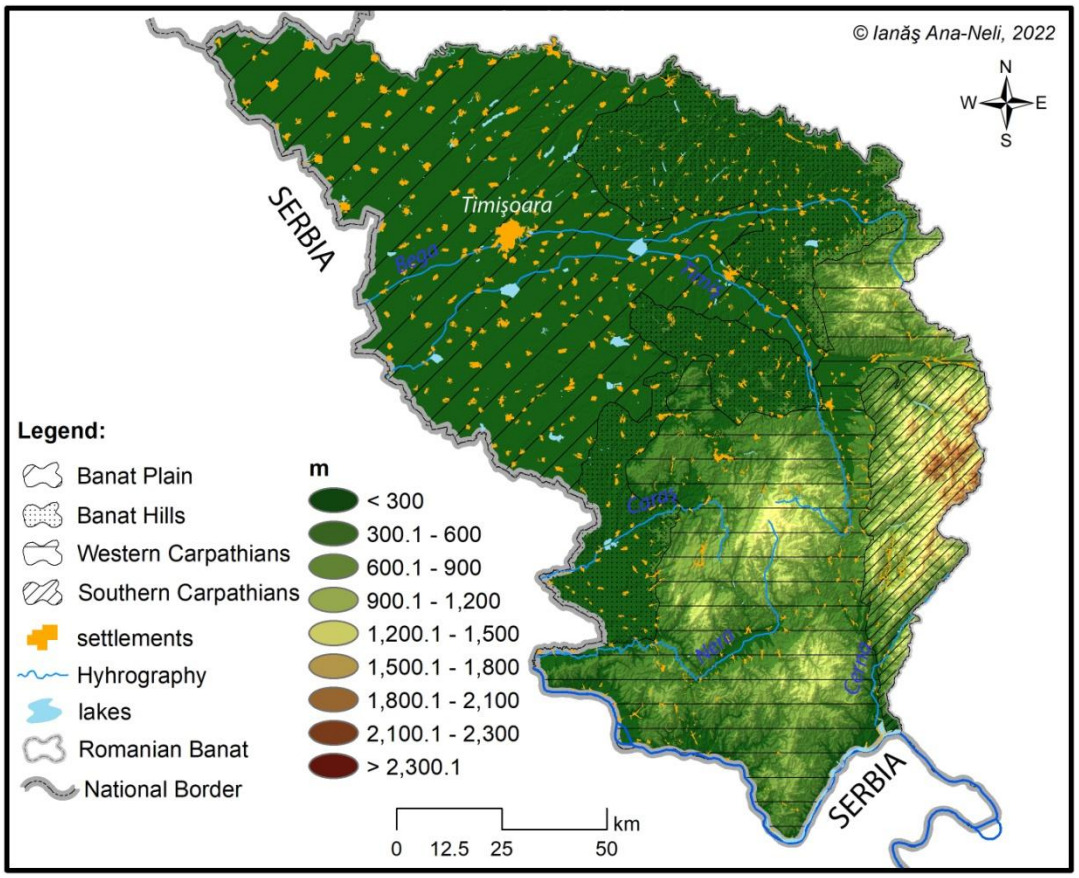

Figure 2. The relief in Romanian Banat

The Banat Hills form an intermediate, well-defined, piedmonts step, representing areas of ancient settlement. The hills are formed by a series of ridges sloping towards the plain unit to their west, with relatively low altitudes of 200-300 m (Buziaș Hills, Lipova Hills, Lugoj Hills, Tirol Hills) and very rarely above 400 m (Bulzei Hills), (Mihăilescu, 1966; Ielenicz, 1999). The habitat has exploited all types of favourable locations, thus the Banat hills include: valley villages, hillside villages or interfluve villages (Ancuța, 2008). They are widely used for agriculture, the most representative areas being those occupied by vineyards, orchards and grazing.

The Banat Plain occupies about half of the region's territory, being made up of lower sectors, below 100 m (Timiș Plain, Aranca Plain, Jimbolia Plain) and higher sectors, between 100-180 m (Vinga Plain, Bârzava Plain), (Posea, 1997). Over the last few centuries, the lowland area has undergone the most anthropogenic changes (river regulation, deforestation, changes in natural vegetation). Nowadays, the Banat Plain concentrates most of Banat's population and it's the main agricultural region.

3. METHODOLOGY

The methodology underlying this study was first developed and applied by Feranec et al. (2000) for the territory of four European countries (Czech Republic, Hungary, Romania and Slovakia) in order to identify major changes in the landscape between 1970s and 1990s. Subsequently, the same methodology has been applied in

other several studies, realised on a national or regional scale (Feranec et al., 2002; Ot'hael et al., 2004; Vatseva et al., 2006; Feranec et al., 2007; Popovici et al., 2013; Petrișor A.I & Petrișor L.E., 2018; Petrișor et al., 2020) and on a European scale (Feranec et al., 2010). This methodology started from the idea that changes in the landscape can be based on changes in LCLU (Feranec et al., 2000).

Based on this idea, in this study we have analysed LCLU dynamics using the CORINE Land Cover (CLC) database, whose classification system was initiated by the European Environment Agency. CLC data are available for the years 1990, 2000, 2006, 2012 and 2018, are at a scale of 1:100 000, have the ETRS 1989 Lambert Azimuthal Equal Area L52 M10 projection and are provided free of charge by the European Environment Agency (*https://www.eea.europa.eu*) or through the Copenicus Land Monitoring Service (*https://land.copernicus.eu/pan-european/corine-land-cover*). In the present study we used CLC data in vector format, for the years 1990, 2000 and 2018, data that were reprojected in Stereo 70 (Romania's projection system), using ArcMap 10.8.2 software. These years were chosen to make a comparative analysis of the changes in the landscape of the Romanian Banat, both immediately after the change of political regime in 1990 and after 2000 when, at least from a legislative point of view, the situation in Romania became clearer. At the same time, we used level 2 of the CLC classification system nomenclature (Table 1), considering that it best highlights the reality.

Table 1. CORINE Land Cover Nomenclature used in the present study
(Source: https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/htm)

Level 1	Level 2
1. Artificial areas	1.1 Urban fabric
	1.2 Industrial, commercial and transport units
	1.3 Mine, dump and construction sites
	1.4 Artificial non-agricultural vegetated areas
2. Agricultural areas	2.1 Arable land
	2.2 Permanent crops
	2.3 Pastures
	2.4 Heterogeneous agricultural areas
3. Forest and seminatural areas	3.1 Forest
	3.2 Shrub and/or herbaceous vegetation associations
	3.3 Open spaces with little or no vegetation
4. Wetlands	4.1 Inland wetlands
	4.2 Coastal wetlands
5. Water bodies	5.1 Inland waters
	5.2 Marine waters

(Classes with code 4.2 and 5.2 are missing from the Romanian Banat)

Level 2 of the CLC database for the years 1990, 2000 and 2018 was also the basis for the spatial land distribution map and the calculation of the area of each class. Subsequently, the 13 LCLU classes identified in the Romanian Banat were reclassified using ArcMap 10.8.2 software, *reclassify* function and converted to ASCII format for further processing in IDRISI Selva software. This software is very useful in land conversion analysis (Eastman, 2012) and its extension called Land Change Modeler for

Ecological Sustainability allows to overlay maps and identify both the types of landscape changes and the areas affected by these changes. In order to obtain the desired results, we have overlaid the maps of several periods: 1990 with 2000, 2000 with 2018 and 1990 with 2018. For a more relevant analysis, only areas of more than 1000 hectares affected by changes were taken into consideration. Following the processing from IDRISI Selva we obtained 47 classes reflecting areas of more than 1000 ha affected by changes between 1990 – 2018. The results led to the delineation of 14 hotspots more intensely affected by changes. These 14 hotspots were identified using the relief unit boundaries, available free of charge in vector format on the website *http://geo-spatial.org*. Then, for landscape change analysis, the 47 classes were grouped into 7 transitional dynamics (Table 2): urbanization/industrialisation (1), development of agriculture (2), abandonment of agriculture (3), defforestation (4), afforestation (5), floods (6) and others (7), (Petrişor A.I & Petrişor L.E, 2018).

Table 2. Transitional dynamics in Romanian Banat
(Source: https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/htm)

Transitional dynamics	CLC Classes Level 2	CLC Classes Level 2
	FROM	**TO**
1. Urbanization / Industrialisation	2.1, 2.2, 2.3, 2.4, 3.1, 3.2, 3.3, 4.1, 5.1	1.1, 1.2, 1.3, 1.4
2. Development of agriculture	2.3., 4.1, 5.1	2.1, 2.2, 2.4
3. Abandonment of agriculture	2.1, 2.2, 2.4	2.3, 3.2, 3.3
4. Defforestation	3.1	2.1, 2.2, 2.3, 2.4, 3.2
5. Afforestation	2.1., 2.2, 2.3, 2.4, 3.2	3.1
6. Floods	2.1, 2.3, 2.4	4.1, 5.1
7. Others	Affects small areas and includes changes within the same category of land cover and land use. For example: arable land to permanent crops; permanent crops to arable land; shrub and/or herbaceous vegetation associations to open spaces with little or no vegetation; open spaces with little or no vegetation to shrub and/or herbaceous vegetation associations.	

• Urbanisation/Industrialisation – reflects the transformation of all categories of agricultural land, forest, semi-natural areas or wetlands into urban or rural, industrial, commercial, mining, recreational areas.

• Development of agriculture – represents the transformation of pastures and wetlands into arable land, permanent crops or heterogeneous agricultural areas. Heterogeneous agricultural areas includes: "*areas of annual crops associated with permanent crops on the same parcel, annual crops cultivated under forest trees, areas of annual crops, meadows and/or permanent crops which are juxtaposed, landscapes in which crops and pastures are intimately mixed with natural vegetation or natural areas*" (*https://land.copernicus.eu/user-corner/technical-library/corine-land-cover-nomenclature-guidelines/htm*).

• Abandonment of agriculture – represents the transformation of arable land, permanent crops and heterogeneous agricultural areas into other natural elements.

• Deforestation – refers to the disappearance of the forest class and its replacement by other classes.

• Afforestation – includes the conversion of agricultural land and areas covered by shrub and/or herbaceous vegetation associations into forests.

• Floods – are the transformation of natural areas into wetlands (inland wetlands and inland waters).

• Others – affects small areas and includes changes within the same category of land cover and land use.

Finally, the surface area for all 7 transitional dynamics was calculated and the results obtained were validated with existing literature information.

4. RESULTS AND DISCUSSIONS

The amphitheatric landforms, with elevations increasing from West to East and respectively from North to South and South-East, have required a differentiation of LCLU patterns (Figure 3), as well as distinct economic functionality for each landform.

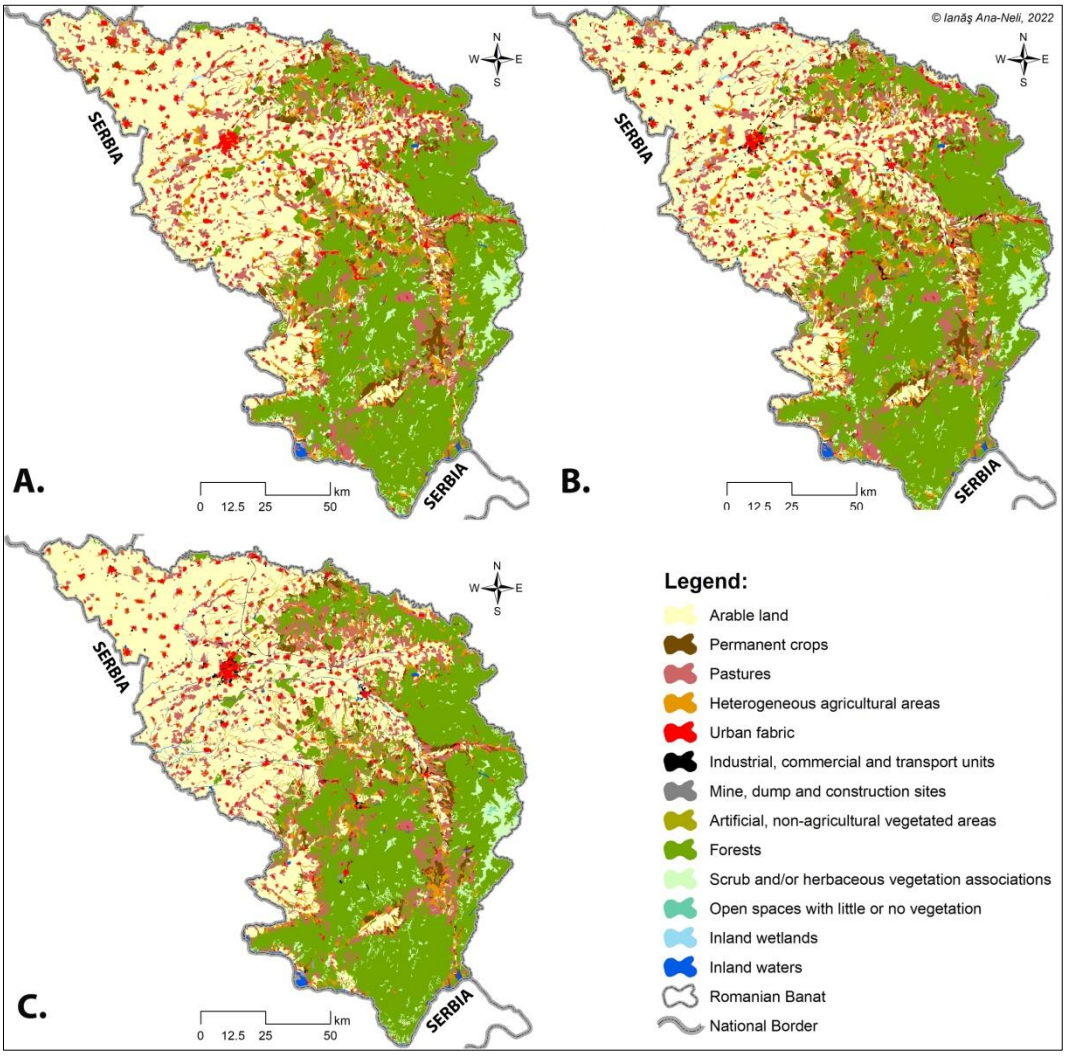

Figure 3. Spatial distribution of LCLU patterns in Romanian Banat, according to CLC data (**A.**1990; **B**. 2000; **C**. 2018)

Thus, the plain unit is dominated by the presence of agricultural and artificial land, with predominantly agricultural (based on crop cultivation) and industrial economic functionality. Within the agricultural land, the largest area is held by arable land, interspersed with heterogeneous agricultural areas. As far as artificial areas are concerned, the lower elevations are the most favorable for the expansion of built-up areas, the location of large towns and the emergence of industrial or commercial units, especially on the outskirts of large towns. The intermontane hills and corridors have the greatest diversity of LCLU and the greatest landscape fragmentation. Here heterogeneous agricultural areas predominate, with grassland and permanent crops interspersed with non-agricultural, predominantly forested areas. Agricultural functionality predominates here, too, but mainly based on animal husbandry and less on plant cultivation. The mountainous altitude has the industrial functionality linked to the wood exploitation and supported by the extensive forest areas, especially broad-leaved forests, existing in the Banat Mountains, the Poiana Rusca Mountains and the West of the Retezat-Godeanu group in the Southern Carpathians. Analysis of the spatial distribution of LCLU classes (see Figure 3), as well as their dynamics, revealed more pronounced changes in the mountain and hilly landscape. Thus, Caraș-Severin county and the Eastern part (with high relief) of Timiș county were affected by the most obvious changes between 1990s and 2018s. It also shows that major changes in the landscape of the region occurred after 2000s (Figure 4).

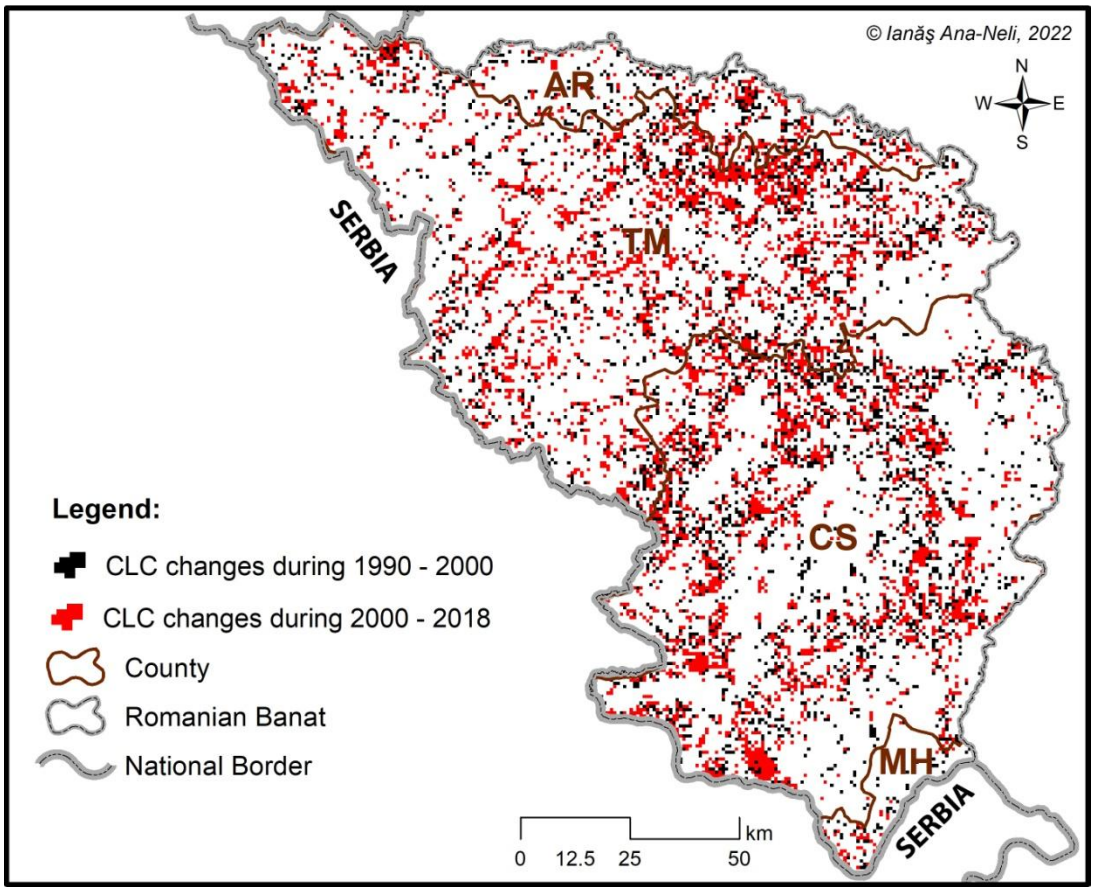

Figure 4. Landscape changes in Romanian Banat, according to CLC database

The main changes affecting the land in this study area are grouped into 7 transitional dynamics, analyzed over two periods (1990 - 2000 and 2000 - 2018). It can be seen that in the first 10 years after the transition to a market economy and the change of political regime in Romania, land dynamics did not change as much as in the period 2000-2018 (Figure 5). This is also due to the fact that the transition period began with a series of legislative measures directly responsible for land use changes, such as "Decree Law 42/1990, Land Law 18/1991, supplemented and amended by Law 169/1997 and Law 1/2000, Law 247/2005" (Popovici, 2010, p. 102). All these laws provided for the restitution of agricultural and forestry land to the former owners or their heirs, a process that took several years. Thus, private ownership became dominant in all categories of land use, which had as a first consequence the fragmentation of land and the change in the type of land use (Popovici, 2010). The result is visible in the landscape of the region after the 2000s and especially after Romania's accession to the EU in 2007 (Figure 5). In this context, Romania has benefited from non-reimbursable European funds in the field of agriculture and rural development through certain programs specific to both the pre-accession period (PHARE, ISPA and SAPARD) and the post-accession period (EAGF, EAFRD, EFF). To these European funds must be added the amounts from the national budget (Popovici et al., 2016).

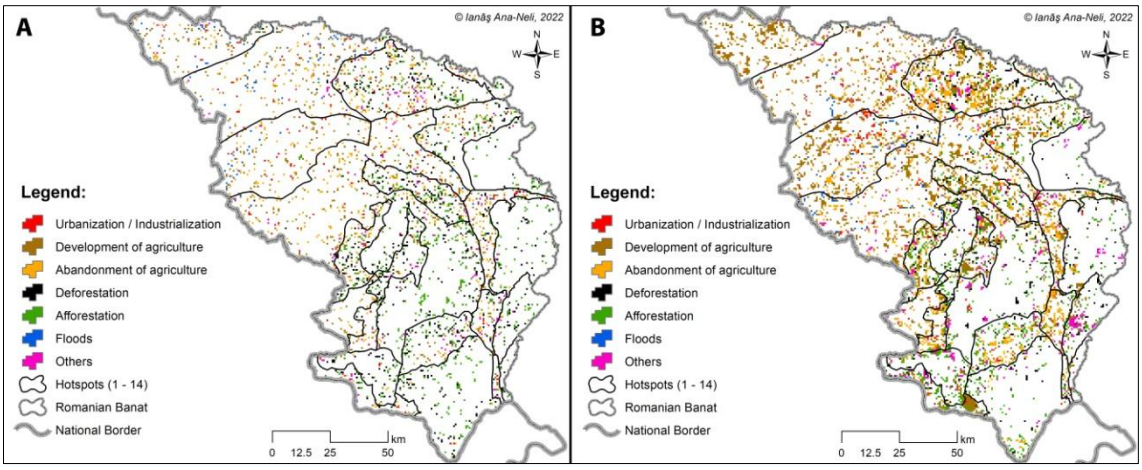

Figure 5. Transitional dynamics in Romanian Banat, according to CLC database (**A**. period 1990 – 2000, **B**. period 2000 – 2018)

Depending on the areas affected by the changes, 14 hotspots have been defined (see Figure 6), 11 of which are in the hills, depressions and valley corridors, 2 in the lowlands and 1 in the mountain area. The hilly and depressional unit has been affected by the most intense changes in LCLU, reflected in processes such as abandonment of agriculture, deforestation and afforestation in some parts. Lowland areas show the highest transitional dynamics related to agricultural land and, especially, the urbanization/industrialization process (see Figure 7). In the mountainous area, the representative is the renaturalisation of the landscape through afforestation and the development of shrub vegetation in deforested areas. This is also due to the fact that most of the mountain area of the Romanian Banat overlaps protected areas (national/natural parks) or Natura 2000 sites.

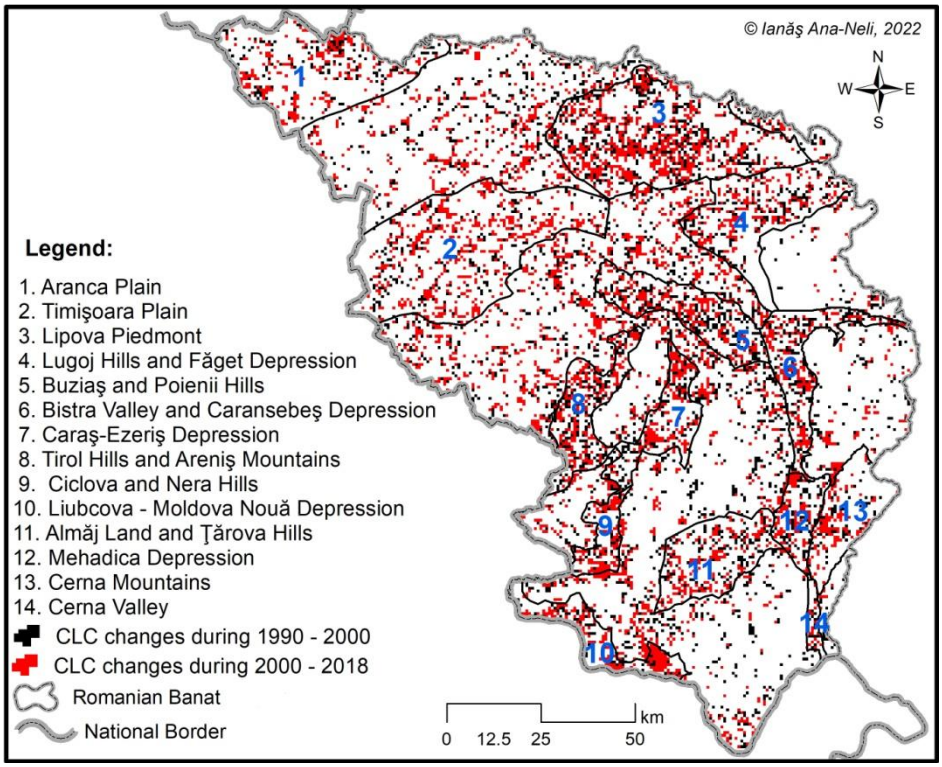

Figure 6. Hotspots concentrating the largest areas affected by transformations in Romanian Banat, based on CLC data

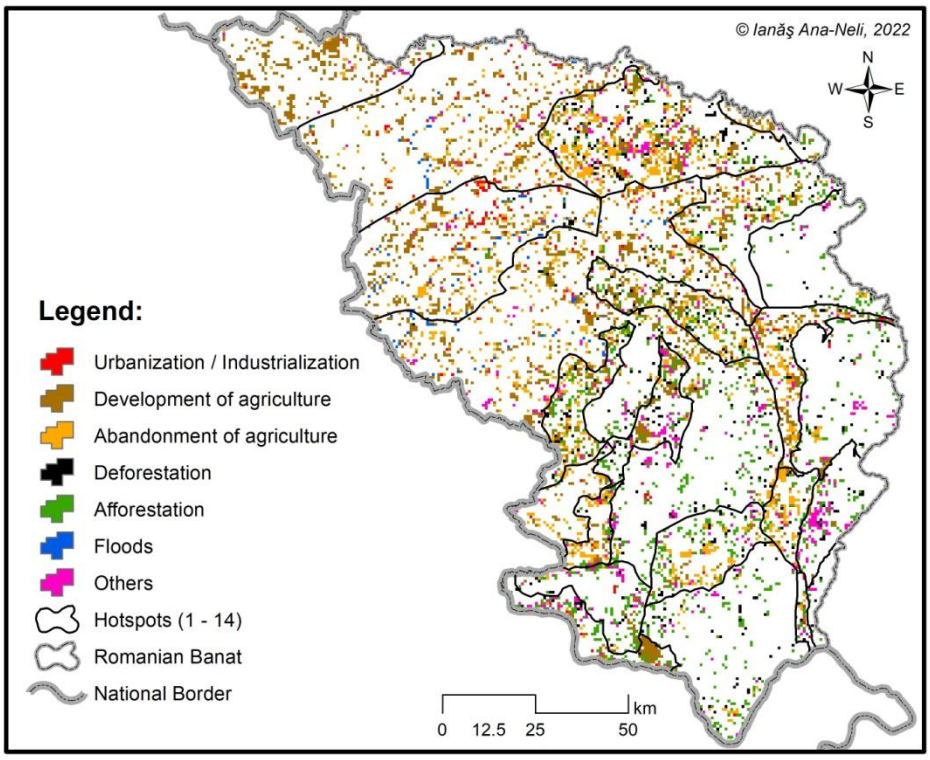

Figure 7. Transitional dynamics in Romanian Banat during 1990 - 2018, based on CLC data

The causes that have contributed to the constant decrease of cultivated land areas and implicitly to the *abandonment of agriculture* on large areas in the hotspots overlapping hill areas (Lipova Hills - 15771 ha, Tirol Hills - 4360 ha, Lugoj Hills and Făget Depression - 3770 ha) and some of the depressions (Almăj Land - 4313.95 ha, Bistrița Valley and Caransebeș Depression - 4638. 47 ha), (see Table 3) were the following: land reforms, constant degradation of the productive capacity of the land due to excessive land and property fragmentation (Bălteanu & Popovici, 2010), but especially the emigration of the population from rural areas to the large urban centres of the region (Timișoara, Lugoj, Reșița, Caransebeș), (Ianăș, 2011, 2013; Otiman, 2017). Emigration to the cities has been a widespread phenomenon since the communist period, as a result of the collectivisation of all agricultural properties (with small exceptions in mountainous areas) on the one hand, and the increased attractiveness of cities through the development of large industrial capacities on the other. In this context, villages experienced a regression in terms of efficiency and dynamism, most of them being incapable of self-sustainability and self-organization after 1990s (Ancuța et al, 2015). The pronounced socio-economic vulnerability of many rural settlements in the mountain and hill areas of Banat, the sharp demographic decline in some rural localities, the lack of financial resources and the practice of a subsistence economic model in agriculture (Ancuța et al., 2015), the high proportion of elderly people, but also the poor assistance farmers received from the state (Bălteanu & Popovici, 2010) have contributed to the abandonment of agricultural land exploitation in the mentioned areas (see Table 3). As livestock numbers continued to decline, pastures and natural meadows were also abandoned. In the case of Timisoara Plain, the phenomenon of abandonment of agriculture, which affected about 7000 hectares (see Table 3), was closely linked to the removal from the agricultural circuit of numerous plots of land outside the municipality of Timisoara and nearby communes, as a result of population growth and the expansion of land occupied by buildings (residential, industrial, commercial, services) and roads (especially the road network). In the context of increasing interest in acquiring agricultural land and converting it into built-up areas, many landowners have abandoned important agricultural areas in anticipation of potential buyers (Ancuța et al., 2013).

Thus, the process of *urbanization* is most evident in Timișoara Plain, being a process linked to the concentration of the population, to the territorial mobility of the population in the surrounding areas. This process affected about 2700 hectares in the Timișoara Plain (see Table 3), being strongly influenced by the presence of the city of Timișoara, the most important urban pole in demographic and economic terms in the Banat region (Vesalon & Creţan, 2019). It should also be noted that while urbanization influences land use by adapting agricultural production to the needs of the urban population, industrialization, on the other hand, can contribute to land degradation and can be a major source of pollution (Popovici, 2010). The most spatially concentrated process is *agricultural development*. Two hotspots with remarkable positive dynamics of land for agricultural development have been identified: Aranca Plain (about 14300 ha) and Timisoara Plain (about 13900 ha), (see Table 3). After the 2000s and especially after Romania's accession to the EU, large agricultural holdings developed in these areas as a result of leasing or buying land (including by foreign investors, after the application of Law 247/2005 and Law 312/2005). The increase in the number of large farms and the practice of efficient farming have also been supported by the adoption and implementation of the Common Agricultural Policy (CAP).

Table 3. Transitional dynamics in Romanian Banat (1990 – 2018)

Hotspots	Landscape changes 1990 – 2018 (ha), accordind to CORINE Land Cover Database						
	Urbanization / Industrialization	**Development of agriculture**	**Abandonment of agriculture**	**Deforestation**	**Afforestation**	**Floods**	**Others**
Aranca Plain (1)	151.01	14327.77	1137.40	124.17	175.86	84.52	627.48
Timişoara Plain (2)	2737.74	13883.89	6959.72	477.63	381.79	2229.43	606.52
Lipova Piedmont (3)	299.53	13313.83	15771.17	6058.78	4281.66	0	4309.36
Lugoj Hills and Făget Depression (4)	446.33	6576.57	3770.03	1361.18	3496.74	1.86	684.7
Buziaş and Poienii Hills (5)	35.76	6981.27	4025.95	2188.48	3733.33	0	557.4
Bistra Valley and Caransebeş Depression (6)	334.79	6680.88	4638.47	614.42	1125.04	0	1005.94
Caraş-Ezeriş Depression (7)	0	3700.61	1174.23	1475.5	2953.08	0	2362.28
Tirol Hills and Areniş Mountains (8)	112.5	4382.46	4360.28	1955.5	4553.45	34.53	768.22
Ciacova and Nera Hills (9)	168.75	1348.7	3296.13	288.85	1310.59	0	684.09
Liubcova – Moldova Nouă Depression (10)	261.57	4065.91	335.56	629.2	2850.35	129.3	1506.4
Almăj Land and Ţărova Hills (11)	94.76	1425.48	4313.95	1003.53	4322.3	0	1066.02
Mehadica Depression (12)	78.03	1123.41	4429.1	464.57	1196.52	0	471.91
Cerna Mountains (13)	24.2	645.77	150.73	843.78	2391.52	0	3029.5
Cerna Valley (14)	217.69	168.75	363.23	179.59	565.64	56.25	223.26
Romanian Banat	**9345.09**	**127149.45**	**81842.57**	**27405.18**	**58549.41**	**6097.19**	**29514.24**

Although the process of abandonment of agriculture in Lipova Hills is marked as shown above, the human settlements in the Western part of the area, located in contact with the lowland area, are characterized by an important development of agriculture, especially in the period 2000-2018 (see Table 3). The development of agriculture is also a process present in some hotspots that overlap depression and valley areas (Bistrita Valley and Caransebeș Depression, Liubcova - Moldova Noua Depression) or low hills (Buziaș Hills, Tirol Hills and Areniș Mountains, Lugoj Hills and Făget Depression), (see Table 3 and Figure 7), this process being the result of forms of association between small farmers in order to access EU funds more easily (Ianoș & Secăreanu, 2020).

The identified changes in forest cover are associated with two antagonistic processes: *deforestation* and *afforestation*. During the analysed period, deforestation affected forest areas in the Lipovei Hills (about 6000 ha), especially in the Eastern part, the Buziaș Hills (about 2000 ha), Almăj Land and Țărova Hills (about 1000 ha), (see Table 3 and Figure 7). Defforestation, in many cases illegal, is a consequence of the process of returning forest areas to their rightful owners following the adoption of three laws: Law 18/1991, Law 1/2000 and Law 247/2005 (Dutcă & Abrudan, 2010). Afforestation is present in most hotspots in the hilly area (see Table 3 and Figure 7) and is the result either of tree planting (financially supported after 2000s by the SAPARD programme and later by local and central government initiatives) or of natural regeneration of tree species, especially on abandoned agricultural land. An analysis of the two processes at the level of the 14 hotspots shows that more than 58500 ha have been afforested, twice the area deforested (about 27000 ha), (see Table 3).

Transformations in the *floods* category affected about 2535.89 ha in the Banat region (see Table 3), with a larger extension in the western part of the Timișoara-Bega Plain (Timișoara Plain and Arancai Plain) due to their geomorphological and geological characteristics. Both are low plains, with alluvio-proluvial deposits (Timișoara Plain) and fluvio-lacustrine deposits (Arancăi Plain), affected by subsidence processes (Ianoș, 2008). These aspects, together with climatic particularities, have created favorable conditions for the occurrence of hydrological risk phenomena (Arba, 2017), with the floods of 1999, 2000, 2005 and 2006 (Aldescu, 2010) being mentioned in the literature, which destroyed many types of agricultural land and contributed to the expansion of wetlands. Another important consequence has been the decline in soil quality, which has caused changes in LCLU. For example, the assessment of agricultural land after the 2005 floods showed a major decline in quality for all agricultural uses and crops grown on arable land, with arable land shrinking (Ianoș, 2008) and being replaced by wetlands and rarely by pastures.

An analysis of all the areas affected by the processes identified on the basis of CLC data, level 2, shows that the largest changes in LCLU occurred in Lipova Hills (about 44000 ha, representing 31.65% of the relief unit area and 2.31% of the region area), followed by Timisoara Plain (about 27000 ha, i.e. 1.43% of the region area), Aranca Plain, Tirol Hills and Areniș Mountains etc. (see Table 4).

Table 4. Areas affected by changes in Romanian Banat (1990 – 2018)

Hotspots	Total area (ha)	Landscape change (1990-2018) – (ha)	% of the hotspot area	% of Romanian Banat
Aranca Plain (1)	99673.00	16628.21	16.68	0.87
Timişoara Plain (2)	156404.41	27276.72	17.44	1.43
Lipova Piedmont (3)	139147.04	44034.33	31.65	2.31
Lugoj Hills and Făget Depression (4)	73178.75	16337.41	22.33	0.86
Buziaş and Poienii Hills (5)	50703.54	17522.19	34.56	0.92
Bistra Valley and Caransebeş Depression (6)	42863.10	14399.54	33.59	0.76
Caraş-Ezeriş Depression (7)	35268.04	11665.70	33.08	0.61
Tirol Hills and Areniş Mountains (8)	42872.91	16166.94	37.71	0.85
Ciacova and Nera Hills (9)	18426.06	7097.11	38.52	0.37
Liubcova – Moldova Nouă Depression (10)	32050.53	9778.29	30.51	0.51
Almăj Land and Ţărova Hills (11)	52587.71	12226.04	23.25	0.64
Mehadica Depression (12)	23360.78	7763.54	33.23	0.41
Cerna Mountains (13)	41100.52	7085.50	17.24	0.37
Cerna Valley (14)	6230.31	1774.41	28.48	0.09
Romanian Banat	**1904754.71**	**339903.10**	**17.84**	**100**

5. CONCLUSIONS

After the 1990s, the change of political regime and the transition to a market economy resulted in several changes in LCLU. The main factors responsible for these changes were political, economic, technological and demographic. *Political factors* have been represented by a series of legislative measures (especially in the transition period 1990 - 2000) which resulted in: a change in the type of land ownership, with agricultural and forestry land becoming mostly privately owned; a change in the type of land use and the average size of individual farms, with individual farms shrinking to 1-2 ha; an increasing degree of land fragmentation has become increasingly evident etc. *Economic and technological factors* have mainly influenced the type of agriculture practiced (intensive or subsistence). Thus, with the exception of the lowland areas where land is still cultivated in associations, subsistence farming is generally practiced in the hill and mountain areas. In obtaining land from the State during the transition period, small producers were faced with production costs that were far too high compared to their financial possibilities, which led to an annual increase in the uncultivated area and a low degree of mechanization of agricultural work. Finally, *the demographic factors* responsible for land use change are: the increasing aging of the population, territorial mobility (from rural areas to big cities and from Romania to Western European countries), level of education, etc.

All these factors have caused, between the 1990 and 2018, the conversion in LCLU of about 17.84% (339903.10 ha) of the Romanian Banat territory . Land changes were more evident in the landscape of hills and depressions or valley corridors (Ciacova and Nera Hills - 38.52%; Tirol Hills and Areniș Mountains - 37.71%; Buziaș and Poienii Hills - 34.56%; Bistra Valley and Caransebeș Depression - 33.59%; Mehadica Depression - 33.23; Caraș-Ezeriș Depression - 33.08% and Lipova Piedmont - 31.65%), followed by lowland and then mountain subunits. Thus, in hilly areas *agricultural land abandonment* and *deforestation* predominate, in lowland areas *agricultural development*, *urbanization/ industrialisation* and *floods*, and in mountainous areas *afforestation* and, in some cases, *deforestation*. At the same time, at the process level, the quantitative analysis of the 7 transitional dynamics identified using CLC database, level 2, revealed that, in the Romanian Banat, most areas are affected by development of agriculture (127149.45 ha, i.e. about 6.67%), followed by abandonment of agriculture (81842.57 ha, i.e. 4.29%) and afforestation (58549.41 ha, i.e. 3.07% of the area of the region). The most intense changes in the landscape of the Romanian Banat are evident after Romania's accession to the European Union in January 2007, thanks to the numerous funds that could be accessed and used in the field of agriculture and rural development. Therefore, the present study makes relevant contributions to the issue of changes in LCLU in the post-communist period, using the CLC database, which has been further developed in many studies at international level (Feranec et al., 2000, 2002, 2007, 2010; Van Dijk, 2003; Ot'hael et al., 2004; Vatseva et al., 2006 ; Hostert et al, 2008, Kuemmerle et al., 2009; Václavík&Rogan, 2009; J Müller et al., 2010; Hartvigsen, 2014, Bański, 2018, Kucsicsa et al., 2018). This study represents a scientific approach that can be used as a model in similar approaches at regional level, using relief units as analysis areas.

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