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LAND COVER CHANGES OF THE BELGRADE AREA OVER THE PAST THREE CENTURIES

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This paper studies land cover changes of Belgrade over the past three centuries. For this purpose we applied an interdisciplinary approach by integrating historical and landscape ecological perspectives. We have produced four reconstruction maps presenting land cover at the turn of the 18th, 19th, 20th and 21st centuries, based on historical maps and written sources. The conversion of the land cover from historical maps was done based on CORINE Land Cover level 3, while Land Cover level 1 was used for displaying on the reconstruction maps. This allowed us to compare the changes that occurred from the turn of one century to the next. It has been determined that the land cover of Belgrade has transformed from dominantly semi-natural in the 18th century, to agricultural in the 19th century, and artificial in the 20th century. We have determined that the driving forces of the land cover changes were activities that were part of the political agendas of various states that governed Belgrade. The present analysis bridges the gap in the relevant literature on the land cover changes in Belgrade in the long-term, and provides qualitative and quantitative results relevant for research-based management actions, planning processes and restoration ecology.

Key words: **land cover changes, landscape history, driving forces, interdisciplinary approach, Belgrade.**

INTRODUCTION

The landscape is part of the heritage whose patterns were inherited from earlier times, therefore the understanding of the present relies on knowing the past (Marcucci, 2000). Over the past centuries, the anthropogenic impact on the landscape has vastly increased in intensity and range. Observed through the land cover lens, the greatest changes at the global level were caused by the permanent use of land for agriculture and settlements (Ellis *et al*., 2010; Plieninger and Bieling, 2012). The conversion of natural ecosystems to agriculture is considered to be the most significant historical land cover change (Ramankutty and Foley, 1999). Urbanization, which was greatly driven by industrialization, led to the vigorous growth of the artificial land cover (Antrop, 2004; Liu *et al*., 2016). Hence, studying landscape changes invites an interdisciplinary approach, integrating landscape ecology and history, to understand the underlying processes and to address practical problems society is facing (Bürgi and Russell, 2001).

The causes, processes, and consequences of the land cover change in East Europe are attracting growing interest among scholars (Gutman and Radeloff, 2017). However, in the case of Serbia and the Belgrade Area the history of the land cover and drivers of their changes are almost unexplored (Plieninger *et al*., 2016). In this paper we look at the land cover changes in Belgrade, the capital of the Republic of Serbia, over the past three centuries. We have considered the land cover changes caused by a combination of political, cultural and socioeconomic driving forces, particularly focusing on distinct governmental policies. The aim was to quantify the land cover changes in the Belgrade Area and to describe the relationships between different governmental policies and the land cover changes during a period of three centuries, from 1717 to 2017. Using the theoretical and methodological framework of the interdisciplinary approach and multiple-source historical data analysis, we have provided entirely new qualitative and quantitative results on long-term land cover changes in the Belgrade Area.

The purpose of the study that we have conducted lies in the analysis and synthesis of the causes and effects, which leads to the reconstruction of the trends in land cover change, and the answers to the question of why and how the changes occurred and progressed. Also, the purpose of the study was to shed light on the potential perspectives of development

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based on historic reconstruction. The findings and results for the Belgrade Area, presented in this paper, although appearing axiomatic at first glance, are completely new and have so far not been explored, and have therefore not been explicated.

MATERIALS AND METHODS

History and research period of the study area

Belgrade is located in the north-central part of the Republic of Serbia, at the confluence of the Sava River into the Danube (Figure 1). The study territory, the Belgrade Area, is a space within the boundaries of the Belgrade Master Plan, and it covers a surface of 77,600 hectares (776 km^2) with a population of 1,310,000 in 2001 (Macura and Ferenčak, 2003). The Belgrade Area consists of three geographic subregions: Šumadija, Srem and Banat subregions (Marković, 1980). These subregions are separated by the Sava and Danube rivers. According to the ecological classification, the Belgrade Area has the natural resources of three biomes (Figure 1, right). One is a hilly biome, with sub-Mediterranean forests of Hungarian oak and Turkey oak in the Šumadija Subregion (elevation 72 m to 511 m). The second is the biome of Southern European deciduous forests of the lowland and inundated type around the Sava and Danube in all three subregions (Banat, Srem and Šumadija), as well as on the lacustrine terrace in the Srem Subregion (elevation 72 m to 84 m). The third is the steppe and forest-steppe biome on the loess plateau only in the Srem Subregion (elevation 72 m to 93 m) (Matvejev and Puncer, 1989).

We analyzed land cover changes in the Belgrade Area and its subregions between 1717 and 2017. During these three centuries the territory was often in different states (Figure 2). In brief: at the turn of the 18th century and during the 19th century, the Srem and Banat subregions were part of the Habsburg monarchy, while the Šumadija Subregion was part of the Ottoman Empire. For two decades during the 18th century (1717–1739) all three subregions were part of the Habsburg monarchy. Later, the Srem and Banat subregions remained part of the Habsburg monarchy until 1918, while the Šumadija Subregion changed from Ottoman to Serbian rule in 1878. After the end of World War One (WWI), all three subregions were merged into the single territory of the City of Belgrade, which became the capital of the newly-created Kingdom of the Serbs, Croats and Slovenes/Kingdom of Yugoslavia, and as of 1945 socialist Yugoslavia. After the disintegration of Yugoslavia, Belgrade became the capital of Serbia once again. All changes in government and states were accompanied by armed clashes and/or large social changes.

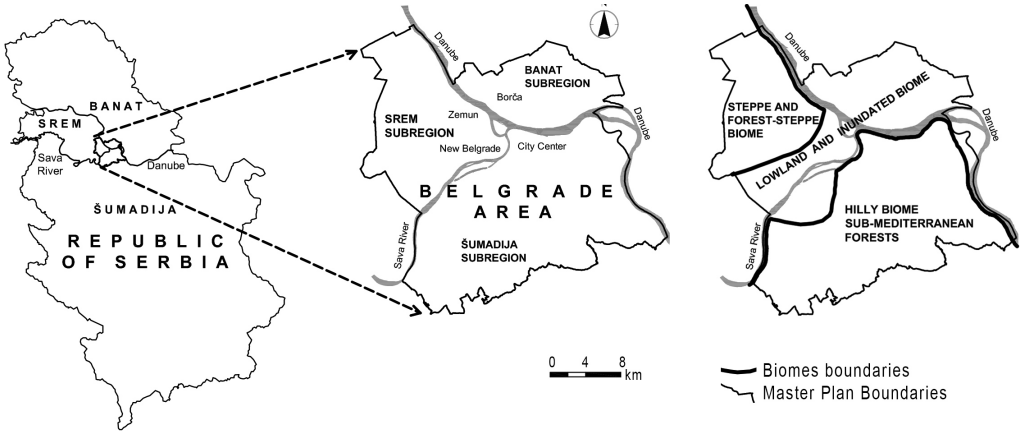

Figure 1. The study territory, the Belgrade Area, a space covered by the Belgrade Master Plan (left). The three geographic subregions of the Belgrade Area, separated by the Sava and Danube rivers (center); the position of three biomes in the Belgrade Area (right).
(Source: authors)

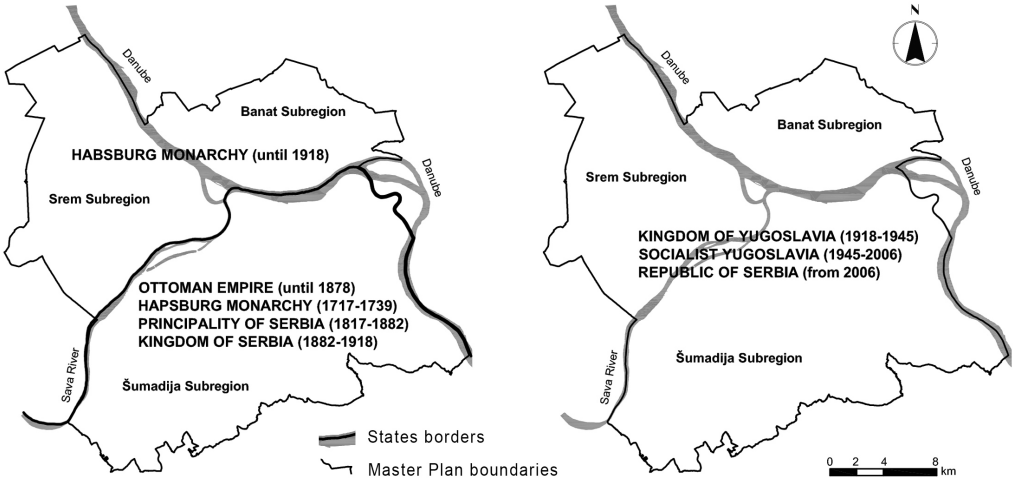

Figure 2. Historic states and geo-political boundaries in the Belgrade Area.
(Source: authors)

Producing reconstruction maps

The method applied to identify processes in the Belgrade Area's land cover changes over the course of three centuries was based on an interdisciplinary approach (Bürgi and Russell, 2001) and multiple-source historical data analysis (Yang *et al*., 2014). Generally, written history speaks about driving forces, and charted history about their effects on land. Using a chronological series of maps it is possible to determine how land cover changed in the past (Haase *et al*., 2007; Skaloš *et al*., 2011), although historical maps need to be aligned, owing to various deficiencies, in order to be compared (San-Antonio-Gómez *et al*., 2014; Fuchs *et al*., 2015). The source maps were acquired from several collections of historical maps, in scales from 1:10,000 to 1:100,000 (Table 1).

The first step in the process of producing reconstruction maps was determining the accuracy of the historical sources (Yang *et al*., 2014), and then establishing unique land cover codes and descriptions. For this purpose we used the CORINE (Coordination of Information on the Environment) hierarchical classification (Bossard *et al*., 2000). CORINE Land Cover (CLC) level 3, was used for defining (description), while CLC level 1 was used for the display on the reconstruction maps (Table 2). This allowed for various data sources to be classified into five land covers, forming a unique and coherent reconstruction map. This also allowed for the comparison of historic maps on various time cross-sections.

ArcGIS 9.0 software, produced by ESRI, was used for map vectorization and data analysis, in the Gauss-Krüger projection. The ArcGIS software package enabled very fast acquisition of spatial data from digitized maps and provides a number of important information that can be explicitly interconnected with different aspects of the functioning of the city area over time. The historical maps were scanned, geo-referenced and superimposed on the vector data of the Existing land use map of Belgrade Master Plan 2003 and the CORINE 2006. The original maps from the 17th, 18th, and even 19th centuries were more or less distorted (Škalamera, 1973), so rubber sheeting had to be used (Haase *et al.*, 2007). The four obtained reconstruction maps provided the data about areas and quantified the surface of areas of each of the five land covers as output. The changes in areas clearly indicate – by decreasing or increasing – what happened to which land cover in the Belgrade Area during each period.

The reconstruction maps were produced for periods around significant historical turning points that initiated social processes that in turn would change the land cover. Consequently, the reconstruction maps are not dated by year, but descriptively. To understand historical land cover changes we used literature from political, social, and other historiography, as well as various written documents. These sources, along with the data from official statistics, were also used for human population dynamics estimates, which are irrevocably linked to understanding changes in land cover.

FINDINGS

Main Land Cover Changes in the Belgrade Area 1717-2017

Drastic land cover changes in the Belgrade Area during the past three centuries are clearly visible from the reconstruction maps (Figure 3) and documented through the land cover structure (Table 3).

Figure 3a and Table 3 show that at the beginning of the 18th century almost the entire Belgrade Area was covered by forest and semi-natural covers. This prevalence existed at the end of the 18th century, but the share of forest and semi-natural coverings had decreased. The agricultural cover increased, as is shown in Figure 3b and Table 3. The true decline of forest and semi-natural covers occurred in the 19th century. By the end of the century these land covers accounted only for about one tenth of the Belgrade Area surface. Parallel to this, the agricultural cover increased, and at the beginning of the 20th century it was seven tenths of the total area (see Figure 3c and Table 3). During the 20th

Table 1. Period covered by the reconstruction maps and main cartographic sources

Period covered by reconstruction map	Year and main subject of the selected historical maps used to produce the reconstruction maps
Turn of 18th century	1688 Map of the Siege of Belgrade (Joan Baptista Gumpp), 1: 17,600, NLS, Kr II-600 1717 Map of the Route and the Siege of Belgrade, 1: 14,400, NLS, Kr II-437 1721 Map of Belgrade and its Surroundings (Hauptmann Amman), 1:12,200, OStA, KA, Gib 25 1763-1787 First Military Survey B IX a 577 [Temeschwarer Banat 1769–1772], map sheets: 137, 138, 150 and 151, 1:28,800; http://mapire.eu/en/
Turn of 19th century	1788 Map of Belgrade and Wider Surroundings of Šumadija and Srem, 1: 28,000; OStA, KA HIIIe 3044 1788 Map of Belgrade and the Immediate Environment, 1:28,800; OStA, KA, BIIIa 239 1789 Map of the Siege of Belgrade, 1:10,000; NLS, Kr I-52 1806-1869 Second Military Survey B IX a 530 [Ungarn], map sheets: 73XXXVIII, 73XXXIX, 74XXXVIII and 74XXXIX, 1:28,000; http://mapire.eu/en/
Turn of 20th century	1869-1887 Third Military Survey, 1: 75,000; http://mapire.eu/en/ 1893 Serbian Military Map of Belgrade, 1: 75,000; NLS, Kr II-1-20, Kr II-1-27, Kr II-1-28 1895-1897 Map of Belgrade and the Northern Part of Šumadija, 1: 25,000; OStA, KA, Gib 57-3 1913-1916 Map of Zemun, Belgrade and Pančevo, NLS, Kr II-15-26XXI
Turn of 21st century	2003 Existing Land Use (Belgrade Master Plan, 2003), 1: 20,000; Urban Planning Institute of Belgrade 2003 Type of Green Areas (Belgrade Master Plan, 2003), 1: 20,000; Urban Planning Institute of Belgrade 2006 CORINE Land Cover Serbia, 1:100,000; Belgrad, EvroGeomatika 2016 Existing Land Use (Belgrade Master Plan, 2016), 1: 20,000; Urban Planning Institute of Belgrade

(Source: prepared by authors; source information: National Library of Serbia (NLS), Austrian State Archives (OStA, KA), http://mapire.eu/en/, Urban Planning Institute of Belgrade)

Table 2. CORINE Land Cover codes and description, level 1 and level 3, relevant to the Belgrade Area, for 18th, 19th, 20th and 21st centuries

CLC Level 3			CLC Level 1
18th century	19th century	20th and 21st century	
1.1.1 Continuous urban fabric	1.1.1 Continuous urban fabric	1.1.1 Continuous urban fabric	1. Artificial areas
1.1.2 Discontinuous urban fabric	1.1.2 Discontinuous urban fabric	1.1.2 Discontinuous urban fabric	
	1.2.1 Industry and commerce	1.2.1 Industry and commerce	
1.2.2 Main road network	1.2.2 Road and railway network.	1.2.2 Road and railway network	
1.2.3 Port areas	1.2.3 Port areas	1.2.3 Port areas	
		1.2.4 Airports	
1.3.1 Mineral extraction sites	1.3.1 Mineral extraction sites	1.3.1 Mineral extraction sites	
	1.3.2 Levee	1.3.2 Levee	
		1.3.3 Construction area	
1.4.1 Green urban areas	1.4.1 Green urban areas	1.4.1 Green urban areas	
		1.4.2 Sport and leisure facilities	
2.1.1 Non-irrigated arable land	2.1.1 Non-irrigated arable land	2.1.1 Non-irrigated arable land	2. Agricultural areas
		2.1.2 Permanent irrigated land	
2.2.1 Vineyards	2.2.1 Vineyards	2.2.1 Vineyards	
2.2.2 Orchards	2.2.2 Orchards	2.2.2 Orchards	
2.3.1 Pastures	2.3.1 Pastures	2.3.1 Pastures	
2.4.2 Complex cultiv. patterns	2.4.2 Complex cult. patterns	2.4.2 Complex cultiv. patterns	
2.4.3 Agriculture, with significant areas of natural vegetation	2.4.3 Agriculture, with significant areas of natural vegetation	2.4.3 Agriculture, with significant areas of natural vegetation	
3.1.1 Broad leaved forest	3.1.1 Broad leaved forest	3.1.1 Broad leaved forest	3. Forest and semi-natural areas
		3.1.3 Mixed forest	
		3.1.2 Coniferous forest	
3.2.1 Natural grassland	3.2.1 Natural grassland		
3.2.4 Transit. woodland scrub	3.2.4 Transit. woodland scrub	3.2.4 Transit. woodland scrub	
4.1.1 Inland marshes	4.1.1 Inland marshes	4.1.1 Inland marshes	4. Wetlands
5.1.1 Water courses	5.1.1 Water courses	5.1.1 Water courses	5. Water bodies
5.1.2 Water bodies	5.1.2 Water bodies	5.1.2 Water bodies	

(Source: authors after Bossard et al., 2000)

Table 3. Land covers structure (CLC level 1) of the Belgrade Area through the centuries

CLC level 1	Turn of 18th century		Turn of 19th century		Turn of 20th century		Turn of 21st century	
	ha	%	ha	%	ha	%	ha	%
1. Artificial areas	936	1.2	1279	1.7	3450	4.5	23550	**30.4**
2. Agricultural areas	8193	10.6	29624	**38.2**	54747	**70.4**	38725	**49.9**
3. Forest and semi-natural areas	58521	**75.3**	36082	**46.3**	9082	11.7	10327	13.3
4. Wetlands	5496	7.1	5702	7.4	5638	7.3	983	1.3
5. Water bodies	4454	5.8	4913	6.4	4682	6.1	4015	5.2
Total study area	77600	100.0	77600	100.0	77600	100.0	77600	100.0

(Source: authors)

century, agricultural areas gradually decreased, and at the beginning of the 21st century this land cover accounted for only a half of the Belgrade Area surface. On the other side, the artificial land cover increased extensively. The wetland cover was small at the beginning of the 18th century, and by the early 21st century it had almost disappeared. The described changes had their own dynamics in different subregions over the course of the three centuries. The following sections will describe changes in the subregions examining them from one century to the next.

Semi-natural Eighteenth Century

The 18th century was a period of the Ottoman Empire's dwindling power (Quataert, 2005). However, during that period both powers, the Ottoman and the Habsburg empires, were preoccupied with military and diplomatic activities, so the region around the Sava and Danube rivers, the area of contact and borders, was primitive and neglected with insignificant land cover changes.

The Šumadija Subregion was part of the Habsburg Monarchy for two decades in the 18th century, while the rest of the time it belonged to the Ottoman Empire. Wars between the empires were the main factor driving the population movements. They forced the rural population to abandon their villages, and this population was reduced from 3,500 to 1,750 by the end of the century (Nikolić, 1903). Nevertheless, during this entire century the land cover remained practically unchanged. Forest and semi-natural covers, which accounted for 75.6% of the subregion's area, had decreased by an insignificant 0.7% by the end of the century (Table 4).

The Srem Subregion was part of the Habsburg Military Frontier toward the Ottoman Empire (Ilić, 2014). The crucial driving force in the mid-18th century was the passing of a number of decrees that confirmed the frontiersman obligations of the rural Serbian population to defend the Habsburg Monarchy, and in return their peacetime benefits

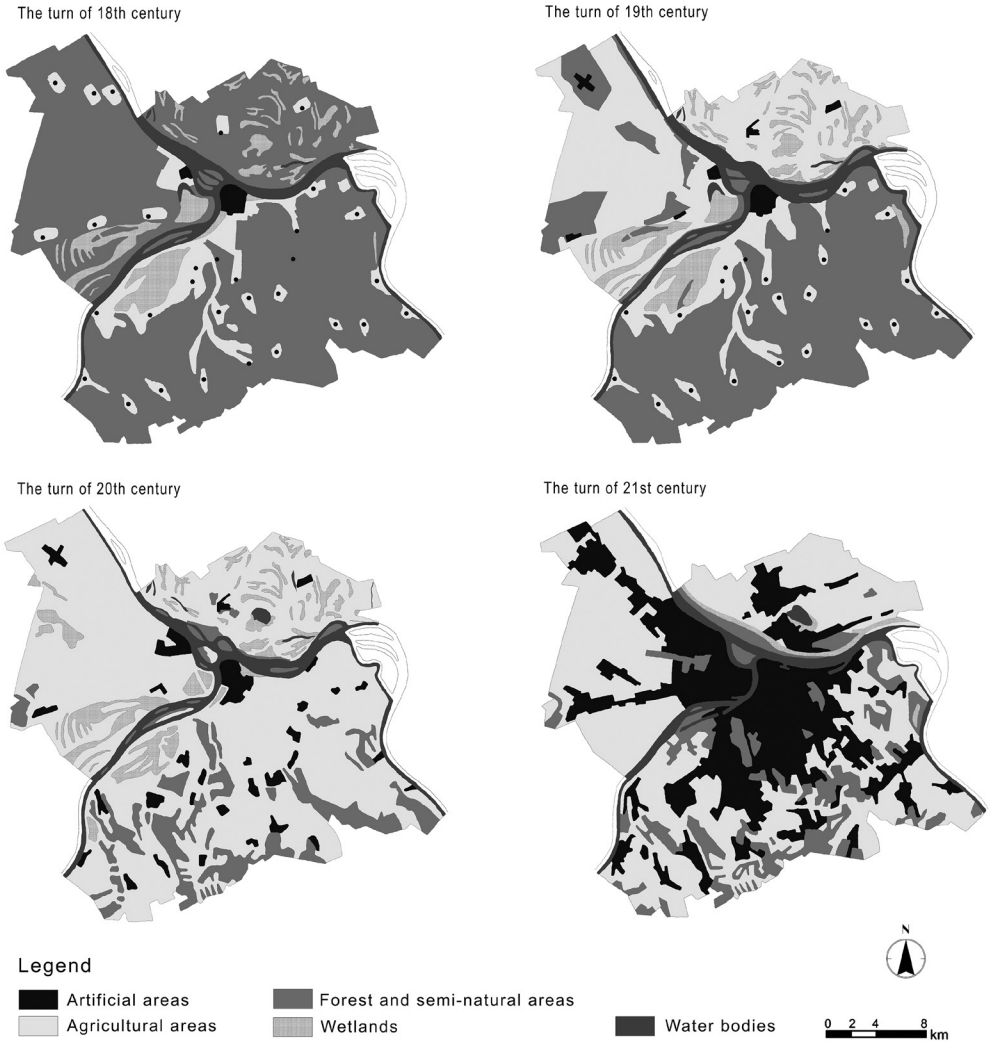

Figure 3. Reconstruction maps of land cover of the Belgrade Area, at the turn of (a) 18th, (b) 19th, (c) 20th and (d) 21st centuries. (Source: drawings by authors)

Table 4. CLC level 1 surfaces (ha) and changes (%) in subregions Šumadija, Srem and Banat in the 18th century

CLC level 1	Šumadija Subregion			Srem Subregion			Banat Subregion		
	Land cover in ha		The change in %	Land cover in ha		The change in %	Land cover in ha		The change in %
	Turn of 18th century	Turn of 19th century		Turn of 18th century	Turn of 19th century		Turn of 18th century	Turn of 19th century	
1. Artificial areas	753	753	0.0	160	353	120.6	23	173	652.2
2. Agricultural areas	6369	6771	6.3	1559	13807	758.6	256	9046	3433.6
3. Forest and semi-natural areas	31132	30908	- 0.7	17384	4855	-72.1	10005	319	-96.8
4. Wetlands	1764	1665	- 5.6	1879	1883	0.2	1853	2154	16.2
5. Water bodies	1424	1574	10.5	1520	1677	10.3	1510	1622	7.4

(Source: authors)

were increased. The rural population increased from 490 to 2,790, while in Zemun, the main town in the subregion, it increased from 1,520 to 3,190. This was accompanied by a 758.6% increase in the agricultural land cover (from 1,559 ha to 13,807 ha), and by a 72.1% decrease in semi-natural covers (from 17,384 ha to 4,855 ha).

The Banat Subregion was also part of the Habsburg Military Frontier (Ilić, 2014). Unlike Srem, it was a wilderness prone to flooding by the Danube. The population of two old villages Borča and Ovča increased from 350 at the beginning of the 18th century to 600 by the end of the century (Đurić, 1953). The bottoms of shallow marches would turn into meadows in the summer, and they were used to graze local livestock and livestock from other parts of Banat. This naturally produced agricultural land accounted for 67.7% of the area of the subregion (9,046 ha), which was an increase of 3,433.6%.

Agricultural Nineteenth Century

During the 19th century the Habsburg authorities gradually brought order to the Srem and Banat subregions steering them towards the European model in the socioeconomic and cultural respect. Unlike this approach, the Ottoman administration in the Šumadija Subregion did not have a modernization capacity, and as the empire declined, the Principality of Serbia gradually gained autonomy (Table 5).

After 1815, gaining the status of a vassal principality within the Ottoman Empire (Ćirković, 2004) was the crucial driving force of the land cover change in the Šumadija Subregion during the 19th century. The principality of Serbia promoted the settlement of newcomers, and the rural population increased 28-fold, from 1,750 at the beginning of the 19th century, to 48,500 at the end (Jagodić, 2004). The population of Belgrade increased from 34,000 to 69,480 (Nikolić, 1903). The response to these processes was deforestation and the creation of arable land and meadows (Jovanović, 1954). At the end of the 19th century the agricultural cover accounted for 69.1% of the subregion. Formerly dominant forest and semi-natural land covers dropped to 19.2%.

In 1867, after the Turkish population and Ottoman military left Belgrade and Serbia, the Habsburg Monarchy abolished the Military Frontier and set up a civil administration in the Srem Subregion. This was the main driver which opened up the process of agricultural modernization. With the establishment of the civil administration, peasant family cooperatives became landowners (Gaćeša, 2007). The rural population grew from 2,790 to 4,300 by the end of the 19th century, and the population of Zemun increased from 3,190 to 15,840. Agricultural land accounted for 77.3% of the area at the end of the century. The authorities raised its productivity through land commassation and road regulation.

The Banat Subregion, also ruled by the Habsburg Monarchy, experienced a peaceful 19th century. The small population, which was 2,590 at the end of the 19th century, was mainly involved in raising livestock (Đurić, 1953). The peaceful situation led to the stabilization of the pasture-based economy of driving livestock from remote areas of Banat. By the end of the 19th century the agricultural land cover accounted for 73.6% of its area.

Artificial Twentieth and Early Twenty First Centuries

The 20th century was full of rough and powerful turning points in the Belgrade Area (Arandelovic *et al*., 2017). After WWI all three subregions – Šumadija, Srem and Banat – merged into the unified Belgrade, which became the capital of the Kingdom Yugoslavia. After WWII, the socialist Yugoslavia modernized the country within a few decades. After the breakup of Yugoslavia, Serbia became an independent state again in 2006.

Following the merger, the Šumadija Subregion was the only one that was intensively inhabited during the period between the two world wars, experiencing intensive immigration mainly by the poor population. Illegal construction flourished in what had previously been agricultural outskirts (Vuksanović-Macura and Macura, 2018). The creation of the socialist Yugoslavia in 1945 launched the industrialization of the country. Planned collective housing estates sprouted in the surrounding agricultural areas, followed by a new wave of illegal construction in the 1970s. In the 20th century population of the Šumadija Subregion increased from

Table 5. CLC level 1 surfaces (ha) and changes (%) in subregions Šumadija, Srem and Banat in the 19th century

CLC level 1	Šumadija Subregion			Srem Subregion			Banat Subregion		
	Land cover in ha		The change in %	Land cover in ha		The change in %	Land cover in ha		The change in %
	Turn of 19th century	Turn of 20th century		Turn of 19th century	Turn of 20th century		Turn of 19th century	Turn of 20th century	
1. Artificial areas	753	2477	228.0	353	800	126.6	173	173	0.0
2. Agricultural areas	6771	28726	324.3	13807	17066	23.6	9046	10159	12.3
3. Forest and semi-natural areas	30908	8410	-72.8	4855	464	-90.44	319	613	92.2
4. Wetlands	1665	1198	28.0	1883	2432	29.2	2154	973	-54.8
5. Water bodies	1574	1458	-7.3	1677	1458	13.1	1622	1709	5.4

(Source: authors)

Table 6. CLC level 1 surfaces (ha) and changes (%) in subregions Šumadija, Srem and Banat in the 20th and early 21st centuries

CLC level 1	Šumadija Subregion			Srem Subregion			Banat Subregion		
	Land cover in ha		The change in %	Land cover in ha		The change in %	Land cover in ha		The change in %
	Turn of 20th century	Turn of 21th century		Turn of 20th century	Turn of 21th century		Turn of 20th century	Turn of 21th century	
1. Artificial areas	2477	14358	479.7	800	6796	749.5	173	2366	1267.6
2. Agricultural areas	28726	17862	-37.8	17066	13109	-23.2	10159	7754	-23.7
3. Forest and semi-natural areas	7987	8410	5.3	464	781	68.3	613	1129	84.2
4. Wetlands	1198	70	-94.2	2432	0	-100.0	973	912	-6.3
5. Water bodies	1458	1324	-9.2	1458	1237	-15.2	1709	1435	-16.0

(Source: authors)

68,480 to 930,000. The artificial land cover increased from 6.0% to 34.6% of the subregion area, which was an increase of 479.7% (from 2,477 ha to 14,358 ha) (Table 6).

The Srem Subregion, especially its part along the left bank of the Sava River, was considered for the expansion of Belgrade after WWI, but the beginning of WWII thwarted this initiative. The socialist Yugoslavia decided to resume the realization of this idea, which was a crucial turning point in the process of developing New Belgrade (Blagojević, 2007). In parallel with the development of New Belgrade, Zemun expanded on the loess plateau. The population of the Srem Subregion increased from 20,130 to 424,600 by the end of the 20th century. With the destruction of the agricultural land and wetlands, the artificial land cover increased from 3.7% to 31.0%, which was a change of 749.5% (800 ha to 6,796 ha).

After WWI, and particularly after 1945, the Banat Subregion became interesting for the complete transformation of the remaining wetlands into arable land. This idea was realized with the construction of levees, a system of drainage canals and pumps (Đurić, 1953). After 1945, an agro-industrial complex was created in this area, with a dozen new villages. Some plots of land remained the property of farmers, who would later sell them for illegal construction. Planned settlement was carried out up until the mid-1980s, and subsequently illegal settlement as well. The population increased from 2,590 to 82,200 by the end of the 20th century. The artificial fabric increased from 1.3% to 17.4% of the total area of the subregion, which was an increase of 1,267.6% (from 173 ha to 2,366 ha).

DISCUSSION AND CONCLUDING REMARKS

The turbulent history of the wider area surrounding the confluence of the Sava and Danube rivers includes three no less tumultuous "small" histories of the subregions, which would merge into Belgrade after WWI and develop into the city that we know today. Up to 1919 the three subregions of the Belgrade Area – Šumadija, Srem and Banat subregions – had their separate courses of development. The Srem Subregion was one of Central Europe's gates to the Orient. It was always slightly privileged within the southeast of the Habsburg Monarchy thanks to its frontier position and a large quarantine which, in addition to a sanitary role, also played an economic role in the 18th and first half of the 19th century. The Banat Subregion, even though part of the Habsburg Monarchy, was an inactive area during the 18th and 19th centuries, which should be attributed to its unattractive geographic position, lack of links to relevant roads, and nearly wild inundated wetlands along the Danube. On the right banks of the Sava and Danube rivers was the Šumadija Subregion, with its special history. Its diversity during the late 18th and significant portion of the 19th century was marked by the liberation from the Ottoman Empire.

The differences in these histories of subregions resulted from the differences in long-term policies, strategies and actions of the authorities that controlled them. In the 18th century the Habsburg Monarchy established the Military Frontier, which entailed colonizing the area around the border with the Ottoman Empire (Ilić, 2014). The preventive defense policy of the Principality of Serbia in the 19th century did not differ significantly from the Habsburg policy, since the Principality of Serbia considered colonization as the basic premise for defense from Ottoman harassment of the population and overt attacks. In the early 20th century, the new Kingdom of Yugoslavia envisaged the expansion of Belgrade urban structures in the direction of the liberated Srem and the transformation of the Banat marshy meadows into arable land, along with the construction of bridges across the Sava and Danube rivers as spatial and symbolic factors in strengthening its sovereignty over the acquired subregions (Vuksanović-Macura, 2015).

Different governments had their characteristic practices for shaping and changing the land cover, as well as quite specific approaches to its regulation and maintenance. For centuries the Ottoman Empire had had an efficient administrative apparatus that collected taxes in the Balkans, but after the 18th century the Empire was weakened and did not have the strength to maintain the landscape as a factor of economic vitality. Therefore, there were no significant changes in the land cover, and the Šumadia Subregion remained under forest and semi-natural covers up to the first half of 19th century. Unlike the Ottoman treatment, the Habsburg government strived to make the traditional agricultural regime more efficient in the Srem Subregion (Radulović, 2016). Having carried out commassation and the regulation of roads, in the 19th century the authorities transformed small agricultural plots into large swathes of land suitable for the intensification of production, without changing arable land as the prevailing land cover. Contrary to the changes in the field size, type of crops, and land cover types, which were undertaken in the entire Pannonian Plain, the Habsburg Monarchy did not carry out this scope of works in the Banat Subregion of the Belgrade Area. Therefore, in the late 18th and early 19th century there was a gradual shift from semi-natural land to low-quality pastures, while the wetland area remained unchanged. In the ecological sense, this caused difficulties in natural forest restoration and kept marshiness. In the 19th century, the Principality of Serbia systematically carried out a colonization policy, while the clearing of forest for creating new villages, towns, and agricultural land was both a cultural and an economic process (Macura and Puača, 1995; Ćorović, 2015). Even after gaining autonomy in the late 19th century, there was a strong tradition of deforestation for the purpose of gaining new arable land and urban cover. The consequences were floods and soil erosion on steep terrain.

In the 20th century, after WWI and the unification of the three subregions into the Belgrade Area, the Kingdom of Yugoslavia, and subsequently socialist Yugoslavia, were interested in expanding the urban fabric as a means of accommodating new inhabitants in the process of gradual and later intensive urbanization. In the Kingdom of Yugoslavia, the expansion of Belgrade was basically left to poor newcomers who built modest houses on the edges of the city, while land speculators provided them with plots created on what had previously been agricultural land. This process, which was a response to population pressure, was tolerated by the authorities, even though was illegal (Vuksanović-Macura and Macura, 2018). During the

Socialist Yugoslavia, Belgrade urban land further expanded at the expense of agricultural land, through the large-scale development of large residential blocks (Hirt, 2009). On the other hand, migration to Belgrade continued spontaneously, affecting the land cover, but neither the state nor the city authorities were able to channel it socially, economically or spatially. Therefore, the process of urbanization and inadequate policy were a combination of underlying drivers causing excessive urban sprawl and drastic changes from agricultural to artificial land cover in the Belgrade Area during the 20th century (Zeković *et al*., 2015). In absolute values, there was a similar increase in the artificial land cover in the Šumadija and Srem subregions, while this process was most pronounced in the Banat Subregion, and two times higher than in the other two. Such a trend of accelerated change of agricultural into artificial land has continued in the first decades of the 21st century, in post-socialist Serbia (Krunić *et al*., 2014).

The decisions that initiated the processes of land cover changes were always passed by the top governing authority. Deforestation in the Šumadija Subregion in the early 19th century was initiated and personally managed by the Prince of Serbia. The decisions related to commassation in the Srem Subregion in the 19th century came from Vienna. The decision to expand Belgrade to the territory of the Srem Subregion after WWI came from the Ministerial Council of the Kingdom. The decision to build New Belgrade, to be a symbol of socialism, came from the Communist Party top leadership and the state president. The decision to continue reclaiming the wetlands in Banat after WWII also came from the top of the new socialist government.

Each of the policies carried out during the 18th, 19th, 20th and 21st centuries was the driving force of the drastic changes in the land cover. We have found that during the 18th century *wartime operations* in the Belgrade Area led to the renaturalization of the land cover by shifting the population; in the 19th century *immigration* and the *colonization* of the Belgrade Area led to deforestation, reclaiming of wetlands and commassation of land, which expanded the agricultural land cover; finally, the *urbanization* of the Belgrade Area in the 20th century, supported by the creation of the first and second Yugoslavia, resulted in the expansion of the prevailing artificial land cover. A consequence of different processes in the subregions that comprise Belgrade today – geopolitical position, natural environment, the ruling policy, and governing authority – is a historical constant that has brought the system, structure, form, and function of the Belgrade Area land cover to its present state.

In the past three centuries the artificial land cover growth has proven to be very stable. Regarding the prospect for the next several decades, one should expect this to continue. In the course of our research we have not noted any trends that would cast doubt onto that. A very small increase in forest and semi-natural covers may also continue. However, further growth of artificial cover, as well as forest and semi-natural covers, will continue at the expense of the agricultural land cover. Considering the fact that the territory of the Master Plan is fixed, it will be necessary to formulate such a developmental policy within its area that will control and direct the growth of developed structures, while at the same time encouraging the development of forest and semi-natural covers, as well as protecting and safeguarding the agricultural cover. Pursuant to such a scenario, it will be necessary to develop new strategies and approaches to planning. In this sense, the Banat Subregion requires special attention from all actors, because it is unquestionable that a new "Danube City" is being created there, but it is insufficiently structured and without clear urbanity.

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REFERENCES

Antrop, M. (2004) Landscape change and the urbanization process in Europe, *Landscape and Urban Planning*, No. 67, pp. 9-26.

Arandelovic, B., Vukmirovic, M., Samardzic, N. (2017) Belgrade: Imaging the future and creating a European metropolis, *Cities*, No. 63, pp. 1-19.

Blagojević, Lj. (2007) *Novi Beograd: osporeni modernizam*. Beograd: Zavod za udžbenike, Arhitektonski fakultet Univerziteta u Beogradu, Zavod za zaštitu spomenika kulture. [Blagojević, Lj. (2007) *New Belgrade: Contested modernisam.* Belgrade: Zavod za udžbenike, Arhitektonski fakultet Univerziteta u Beogradu, Zavod za zaštitu spomenika kulture.]

Bossard, M., Feranec, J., Otahel, J. (2000) *CORINE land cover technical guide: Addendum. Technical report 40*. Copenhagen: European Environment Agency.

Bürgi, M., Russell, E.W.B. (2001) Integrative methods to study landscape changes, *Land Use Policy*. No. 18, pp. 9-16.

Ćirković, S. M. (2004) *The Serbs*. Malden: Wiley-Blackwell Publishing.

Ćorović, D. (2015) Beograd kao evropski grad u devetnaestom veku: Transformacija urbanog pejzaža, doktorska disertacija. Beograd: Arhitektonski fakultet, Univerzitet u Beogradu. [Ćorović, D. (2015) Belgrade as European city in the nineteenth century: Urban landscape transformation, PhD thesis. Belgrade: Faculty of Architecture, University of Belgrade.]

Đurić, V. (1953) *Pančevački rit – antropogeografska ispitivanja.* Beograd: Srpska akademija nauka. [Đurić, V. (1953) *Pančevački rit – anthropogeographical researches*. Belgrade: Srpska akademija nauka.]

Ellis, E.C., Klein Goldewijk, K., Siebert, S., Lightman, D., Ramankutty, N. (2010) Anthropogenic transformation of the biomes, 1700 to 2000, *Global Ecology and Biogeography*, No.19, pp. 589-606.

Fuchs, R., Verburg, P.H., Clevers, J.G.P.W., Herold, M. (2015) The potential of old maps and encyclopaedias for reconstructing historic European land cover/use change, *Applied Geography*, No. 59, pp. 43-55.

Gaćeša, N. (2007) Privredni razvitak Srema u 19. i 20, in Maticki, M. (ed.) *Srem kroz vekove*. Beograd: Vukova zadužbina, Institut za književnost i umetnosti, pp. 527-568. [Gaćeša, N. (2007) The economic development of Srem in the 19th and the 20th centuries, in Maticki, M. (ed.) *Srem through the centuries*. Belgrade: Vukova zadužbina, Institut za književnost i umetnosti, pp. 527-568.]

Gutman, G., Radeloff, V. (eds.) (2017) *Land-Cover and Land-Use Changes in Eastern Europe after the Collapse of the Soviet Union in 1991*. Cham: Springer International Publishing.

Haase, D., Walz, U., Neubert, M., Rosenberg, M. (2007) Changes to Central European landscapes–Analysing historical maps to approach current environmental issues, examples from Saxony, Central Germany, *Land Use Policy*, No. 24, pp. 248-263.

Hirt, S. (2009) Belgrade, Serbia, *Cities*, No. 26, pp. 293-303.

Jagodić, M. (2004) *Naseljavanje Kneževine Srbije 1861–1880*. Beograd: Istorijski institute. [Jagodić, M. (2004) *Settlement of the Princedom of Serbia 1861–1880*. Belgrade: Istorijski institute.]

Ilić, J.M. (2014) Banatska vojna krajina u drugoj polovini 18. veka, doktorska disertacaija. Beograd: Filozofski fakultet, Univerzitet u Beogradu. [Ilić, J.M. (2014) Banat military frontier in the second half of 18th century, PhD thesis. Belgrade: Faculty of Philosophy University of Belgrade.]

Jovanović, B. (1954) O šumama Srbije početkom XIX veka, *Šumarstvo*, No. VII, pp. 140-158. [Jovanović, B. (1954) About forests of Serbia at the beginning of the XIX. Century, *Šumarstvo*, No. VII, pp. 140-158.]

Krunić, N., Maksin, M., Milijić, S., Bakić, O., Đurđević, J. (2014) Population Dynamics and Land Cover Changes of Urban Areas, *Spatium International Review*, No. 31, pp. 22-29.

Liu, Z., He, C., Wu, J. (2016) The relationship between habitat loss and fragmentation during urbanization: an empirical evaluation from 16 world cities, *PloS One*, No. 11(4), e0154613.

Macura, V., Puača, M. (1995) Promene južnog dela beogradskog predela od XVII veka do danas, *Glas XXXLVI Srpske akademije nauka i umetnosti, Odeljenje društvanih nauka,* No. 27, pp. 169-204. [Macura, V., Puača, M. (1995) Changes of South part of Belgrade's Landscape from XVII century to today, *Glas XXXLVI Srpske akademije nauka i umetnosti, Odeljenje društvanih* nauka, No. 27, pp. 169-204.]

Macura V., Ferenčak, M. (rukovodioci tima) (2003) *Generalni plan Beograda do 2021*. Beograd: Urbanistički zavod Beograda. [Macura V., Ferenčak, M. (team leaders) (2003) *Belgrade Master Plan up to 2021*. Belgrade: Town Planning Institute.]

Marković, J.Đ. (1980) *Regionalna geografija SFR Jugoslavije.* Beograd: Građevinska knjiga. [Marković, J.Đ. (1980) *Regional Geography of SFR of Yugoslavia*. Belgrade: Građevinska knjiga.]

Marcucci, D.J. (2000) Landscape history as a planning tool, *Landscape and Urban Planning*, No. 49, pp. 67–81.

Matvejev, S., Puncer, I.J. (1989) *Karta bioma – predeli Jugoslavije i njihova zaštita*. Beograd: Prirodnjački muzej u Beogradu. [Matvejev, S., Puncer, I.J. (1989) *Map of Biomes – Landscapes of Yugoslavia and their protection*. Belgrade: Prirodnjački muzej u Beogradu].

Nikolić, R.T. (1903) Okolina Beograda, *Srpski etnografski* zbornik, No. 2, pp. 902-1104. [Nikolić, R.T. (1903) Belgrade's Surroundings, *Srpski etnografski* zbornik, No. 2, pp. 902-1104.]

Plieninger, T., Bieling, C. (2012) Connecting cultural landscapes to resilience, in Plieninger, T., Bieling, C. (eds.) *Resilience and the Cultural Landscape: Understanding and Managing Change in Human-Shaped Environments*. Cambridge University Press, pp. 3-26.

Plieninger, T., Draux, H., Fagerholm, N., Bieling, C., Bürgi, M., Kizos, T., Kuemmerle, T., Primdahl, J., H. Verburg, P.H. (2016) The driving forces of landscape change in Europe: A systematic review of the evidence, *Land Use Policy*, No. 57, pp. 204-214.

Quataert, D. (2005) *The Ottoman Empire, 1700–1922*, 2nd ed. Cambridge University Press.

Radulović, S. (2016) Identifikacija i kvantifikacija strukturnih promena u predelima donjeg Srema, doktorska disertacija. Beograd: Univerzitet u Beogradu. [Radulović, S. (2016) Identification and quantification of structural changes in the landscapes of lower Srem, PhD thesis, Belgrade: University of Belgrade].

Ramankutty N., Foley, J.A. (1999) Estimating historical changes in global land cover: Croplands from 1700 to 1992, *Global Biogeochemical Cycles*, No. 13, pp. 997-1027.

Skaloš, J., Weber, M., Lipský, Z., Trpáková, I., Šantrůčková, M., Uhlířová, L., Kukla, P. (2011) Using old military survey maps and orthophotograph maps to analyse long-term land cover changes – Case study (Czech Republic), *Applied Geography*, No. 31, pp. 426-438.

San-Antonio-Gómez, C., Velilla, C., Manzano-Agugliaro, F. (2014) Urban and landscape changes through historical maps: The Real Sitio of Aranjuez (1775–2005), a case study, *Computers, Environment and Urban Systems*, No. 44, pp. 47-58.

Škalamera, Ž. (1973) Planovi Beograda 1688 [Maps of Belgrade 1688], *Urbanizam Beograda*, No. 20, pp. 15–18. [Škalamera, Ž. (1973) Maps of Belgrade 1688, *Urbanizam Beograda*, No. 20, pp. 15-18.]

Tress, G., Tress, B., Fry, G. (2005) Clarifying integrative research concepts in landscape ecology, *Landscape Ecology*, No. 20, pp. 479-493.

Vuksanović-Macura, Z. (2015) *San o gradu: Mađunarodni konkurs za urbanističko uređenje Beograda 1921–1922*. Beograd: Orion art. [Vuksanović-Macura, Z. (2015) *Vision of the City: International urban planning competition for Belgrade 1921–1922*. Belgrade: Orion art.]

Vuksanović-Macura Z., Macura, V. (2018) The Right to Housing: Squatter Settlements in Interwar Belgrade –The Defense and Demolition of Jatagan-mala, *Journal of Urban History,* No 44(4), pp. 755–774.

Yang, Y., Zhang, S., Yang, J., Chang, L., Bu, K., Xing, X., (2014) A review of historical reconstruction methods of land use/land cover, *Journal of Geographical Sciences*, No. 24, pp. 746-766.

Zeković, S., Vujošević, M., Maričić, T., (2015) Spatial regularization, planning instruments and urban land market in a post-socialist society: The case of Belgrade, *Habitat International*, No. 48, pp. 65-78.

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