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Tendencies in Land Use and Land Cover in Serbia Towards Sustainable Development in 1990-2018

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Abstract: The overuse of natural resources by humanity in recent decades has resulted in noticeable changes environment quality. Global environmental research is particularly interested in the topics of land use change and land cover. The Republic of Serbia has a diverse spectrum of landforms, with agricultural use taking up the largest portions, followed by forestry, water, and building land. Significant anthropogenic pressures (such as mining, deforestation, urbanization, and uncontrolled land use, among other things) have harmed Serbia's natural resources over the past two decades. This study examines the causes of specific trends in land-use change in Serbia, utilizing the CORINE Land Cover (CLC) database to track temporal and spatial changes in the major categories of land use and land cover from 1990 to 2018. The authors explained that focusing on the rational use of natural resources is the only way to promote sustainable development, legal alignment with EU law, and prompt adoption of harmonized laws and planning documents across all sectors.

Keywords: CORINE Land-Cover database; Land-cover changes; Land use; Serbia; Sustainable development

1. Introduction

The European Resource Efficiency Strategy establishes the goal of no additional land consumption beyond 2020, according to the EU-LUPA [1]. However, this arrangement will probably go against the interests of many nations, especially those that want to advance economically toward the most alluring European nations.

In actuality, from 1990 to 2006, there were no significant changes in land uses in the European Union (hereafter EU). Serbia is ready to employ land-use change as a tool for financial and economic progress, nevertheless, like many other EU countries. Therefore, it is clear that we are promoting a strong relationship between land use management and development [2-4]. Hence, it is clear to see how our societies are dependent on the land to provide and ensure the resources needed for growth. Nevertheless, our ability to advance is inextricably linked to our need to protect and safeguard the environment as a precious resource [1, 5].

Contextually, it is highly difficult and problematic to analyze the long-term dynamic that has changed the use and purpose of land in Serbia over the past few years. In fact, it may be observed in the extreme agricultural land occupancy for the construction and layout of urban areas and settlements, infrastructure, mining, and industrial zones, among other examples, which results in long-lasting failures of land roles. Therefore, it is increasingly necessary to develop a more integrated, broad, and contemporary method of politics.

As an illustration, consider a strategy that can support sustainable growth through increased effectiveness and a

multifaceted approach. I t is vital to supply new and insightful ways of portraying land-use dynamics and their relationship with social and financial-economic growth in order to provide proof to support such policy objective [1, 6].

In addition, data on Serbia's land usage show that it faces numerous challenges, such as the country's political and economic transformation or efforts to develop energy production sustainably. The CORINE Land Cover (CLC) database for Serbia was created in 2005 and 2006. Since then, the database has enabled us collect data on the land cover of the entire country. As a result, the results of the current research may help the Republic of Serbia develop sustainably.

Geographically, Serbia is a country that surrounds the southern edge of the Pannonian Plain in the center of the Balkans, at the meeting point of Central and Southeastern Europe. The Pannonian lowlands, hilly regions with lower mountains and lowland expansions, and the mountain-valley region are Serbia's three main geographic regions. Fertile plains make up the majority of the country's northern region (Vojvodina), whereas the center and southern regions are primarily mountains. Serbia is home to many stunning natural features, with preserved forests standing out. Therefore, legal and planning tools pertaining to agriculture and forestry, ecological protection, and nature resources are seen as crucial and valuable legal areas in Serbia for sustainably exploiting, organizing, and preserving land resources - as is the case with actions to implement guidelines for conservation and preservation of space as well as to implement new approaches for a responsible use of land assets. Serbia has a population of roughly seven million people and a total area of 88 499 km^2, with more than 50% of the population living in urban areas.

Our methodology is based on research techniques and methods to determine which land use classifications may dominate and have a significant impact on how land use patterns are distributed across the country between 1990 and 2018. To assist land conservation and preservation policies that enhance performance and time efficiency of land use, the selected strategy focuses on offering new geographical representations and methodologies. It also gives evidence of land use and its changes. Regulations serve as the basis for using and managing natural resources, acting as planning documents. This research may be useful to planners in their timely consideration of planning decisions, such as measures for space conservation and protection as well as measures for sustainable use of land resources. This is because only then will we be able to contribute to Serbia's long-term sustainable development. It is also true that illegal and disorderly conversion of agrarian and forest land into building and mining land is not a rare occurrence, which shows that organizations in Serbia face a challenge in managing the implementation of legislative measures. Contextually, sustainable land use in Serbia should involve the continuous application of legal provisions relating to the utilization, protection, and avoidance of environmental deterioration [2].

One of the environmental factors needed to achieve the desired sustainable level is land [1, 7-10]. European policy must take a comprehensive and integrated approach to land use, which requires several compromises between different economic, sociocultural, and ecological challenges [1]. A 2010 EEA report states that these trade-offs can be resolved through integrated land use planning and spatial planning, sectoral policies, and specific policy tools, such as protected area networks." Strategic environmental assessment (SEA) and environmental impact assessment (EIA), as well as primarily the emergence of the CORINE land cover database, are crucial mechanisms for information, monitoring, and evaluation of these policies. Territorial cohesion is a predetermined goal and institutional arrangements that govern land use policy [1, 11].

Wide-ranging uses can be made of developed CLC databases. In this sense, European regions effectively use the CORINE process for land cover cartography, which is quite foreign. Further image processing techniques could improve objectivity and precision in the visual organization of satellite imagery, according to investigations. They ought to be integrated into present practice. Furthermore, CORINE is a key method of obtaining data on land cover and a path to fully utilizing the potential of geographic information systems [12]. Regional studies based on Geographic Information Systems (GIS) Tools and CLC data [13-22] are where the majority of new scholars are concentrating their efforts.

Additionally, a number of academics have researched and examined current land-related laws and shifts in land usage, particularly in relation to alterations in the economy, society, and environment [2, 23-29]. Land use changes from rural to urban can be very profitable, and property development is a key driver of local, regional, and even national economies. Understanding how the land development plan is structured and how various parties profit financially from urbanization will also be necessary to improve the sustainability of urbanization practices [1].

Meanwhile, sustainable development aims to satisfy the needs of a global consumer culture while reducing negative environmental effects. The sustainability concept thus seeks to integrate three pillars of society through its broad application: I sustainable development of economy and technology; (ii) sustainable development based on social balance; and (iii) environmental protection and prudent use of natural resources [1]. The complementarity of these three pillars should be emphasized. Natural capital must be carefully managed because economic and social capital cannot be a substitute for natural capital [1].

The EU-LUPA [1] aims to identify geographical tendencies and patterns of land use in European areas, offer evidence on land-use changes, and sustain an improvement in land-use performance. CLC is one of the initiative's primary sources, and it is mainly used in the following ways: as a tool for identifying land cover changes, as a tool

for identifying land cover changes, and as a tool for identifying anthropogenic activities on the land, which helps us understand regional patterns of land use in Europe.

Moreover, a database has been developed by the ESPON Project SUPER [30] (Sustainable Urbanization and Land-Use Practices in European Regions) 2020 to do analyses by combining data on land use with potential drivers of land-use change. Thus, all information for the four dates of the Corina Earth cover was gathered or converted to NUTS 3 (2016 limits) (2000, 2006, 2012, and 2018). The database is open to the public and has been modified to support user-generated searches.

Since the CLC2000 project and databases were created in Serbia in 2005, other institutions have expressed a strong interest in utilizing the data. The CORINE process, which involves computer-aided visual organization of Landsat 7 satellite imagery sustained with auxiliary data, was used at the time to present the CLC2000 database (topographic maps, airborne imagery, thematic maps). Community Assistance for Reconstruction, Development, and Stabilization is financial assistance provided by the European Union to the West Balkans and includes field monitoring. The outcome was seamless vector dataset with a polygon topology.

The technique determines the mapping scale (1:100,000), minimum mapping unit (25 ha), and minimum width of linear components as its main mapping parameters (100 meters). The IMAGE2000 database served as the basis for the analysis. Protic et al. (2007) stated that the database consists of orthorectified Landsat 7 ETM+ images with a +/- one-year tolerance variation in national projection. By contrasting CLC2000 and satellite images from 2000 (IMAGE2000) with those from 1990, the CLC Changes database is created (IMAGE90). As the difference between two datasets (CLC2000 and CLC Changes), CLC90 was a result of the use of GIS.

2. Methodology

The research area is Serbia, where land use variation is analyzed between 1990 and 2018. In this regard, there are three vital phases. Firstly, the cartography from CORINE Land Cover (CLC) is obtained. It represents the land uses and the administrative limit of Serbia. Secondly, thematic cartography was developed to identify the different kinds of land use and where they are. Thirdly, it was quantified the hectares of every land use.

As for the first phase, CLC provides third levels of land use (Table 1). In this case, level 3 was used since it is the most descriptive.

Table 1. CLC identified in Serbia territory

LEVEL 1	LEVEL 2	LEVEL 3
1 Artificial surfaces	11 Urban Fabric	111 Continuous urban fabric
		112 Discontinuous urban fabric
	12 Industrial, commercial and transport u**nits**	121 Industrial or commercial units
		122 Road & rail networks and associated land
		123 Port areas
		124 Airports
	13 Mine, dump & construction sites	131 Mineral extraction sites
		132 Dump sites
		133 Construction sites
	14 Artificial, non-agricultural vegetated areas	141 Green urban areas
		142 Sport & leisure facilities
2 Agricultural areas	21 Arable land	211 Non-irrigated arable land
	22 Permanent crops	221 Vineyards
		222 Fruit trees & berry plantations
	23 Pastures	231 Pastures
	24 Heterogeneous agricultural areas	242 Complex cultivation patterns
		243 Land principally occupied by agriculture, with significant areas of natural vegetation
3 Forest and semi natural areas	31 Forests	311 Broad-leaved forest
		312 Coniferous forest
		313 Mixed forest
	32 Scrub and/or herbaceous vegetation associations	321 Natural grasslands
		322 Moors and heathland
		323 Sclerophyllous vegetation
		324 Transitional woodland-shrub
	33 Open spaces with little or no vegetation	331 Beaches, dunes, sands
		332 Bare rocks
		333 Sparsely vegetated areas
		334 Burnt areas
4 Wetlands	41 Inland wetlands	411 Inland marshes
5 Water bodies	51 Inland waters	511 Water courses
		512 Water bodies

Figure 1. Location of Serbia in Southeast Europe on the Balkan Peninsula

Geographical allocation of land use and land cover classes in Serbia. Figure 1 shows the location of Serbia in Southeast Europe on the Balkan Peninsula.

3. Results and Discussion

This section analyzes the most relevant and specific land uses in Serbia (Table 3 and Table 4, and Figures 4-6).

Through the analysis of Tables 1, 2, and Figures 1-3, we can perceive the land use changes in Serbia in greater detail. It is possible to identify the significant increase in artificial surfaces in Serbia between 1990 and 2018. The variation of this land class is around 0.59%. Evident is the biggest decrease in agricultural areas in the period 1990-2018 - with a variation of 2.07%. There was a significant increase in forests and semi-natural areas – about 1.3%. An increased tendency is also found in the land class related to wetlands - with an increase of 0.12% between 1990 to 2018. Furthermore, an increase was identified in the water bodies from 1990 to 2018 - a variation of 0.06%.

Table 2. Percentage of land-uses according to level 3 of CLC nomenclature in Serbia

CLC Code	2018
1. Artificial surfaces	3.74%
2. Agricultural areas	55.00%
3. Forest and semi-natural areas	39.72%
4. Wetlands	0.41%
5. Water bodies	1.13%

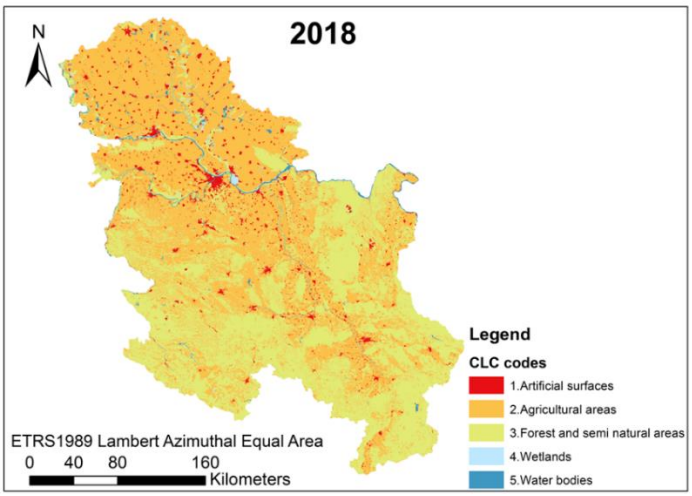

Figure 2. Distribution of land use and land cover categories by major landform units (CORINE Land Cover, 2018)

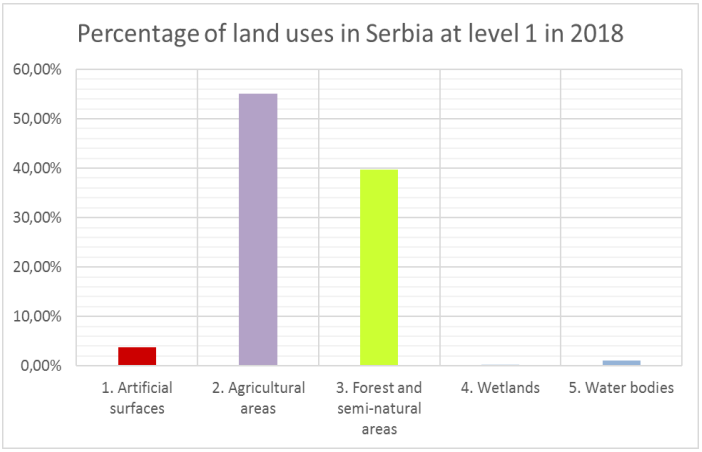

Figure 3. Percentage of land uses in Serbia at level 1 in 2018

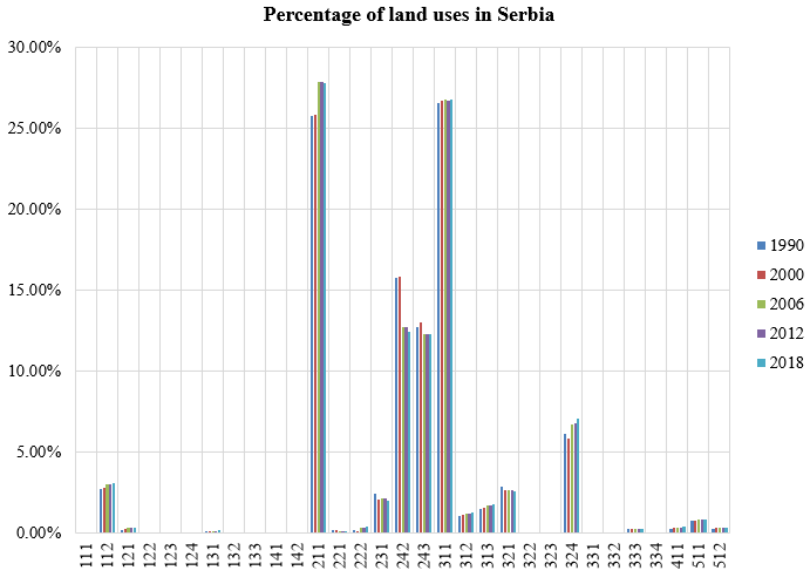

Figure 4. Percentage of land use in Serbia

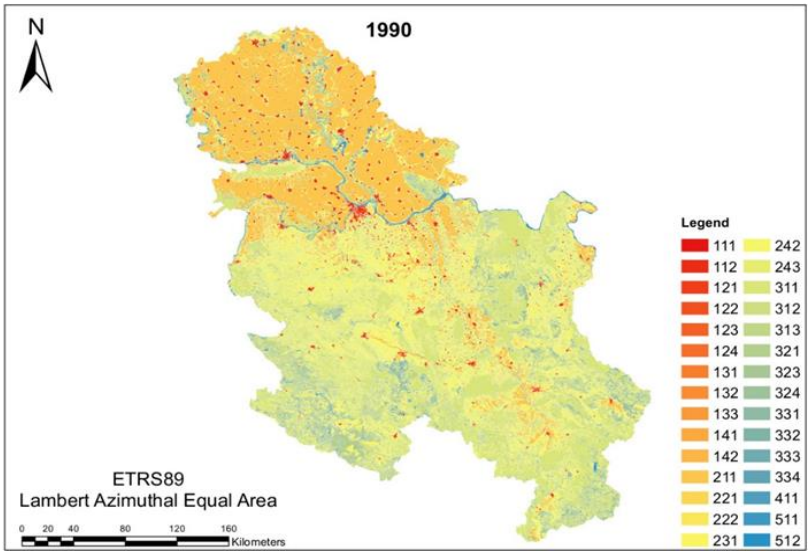

Figure 5. Thematic cartography regarding land-use changes in Serbia in year 1990

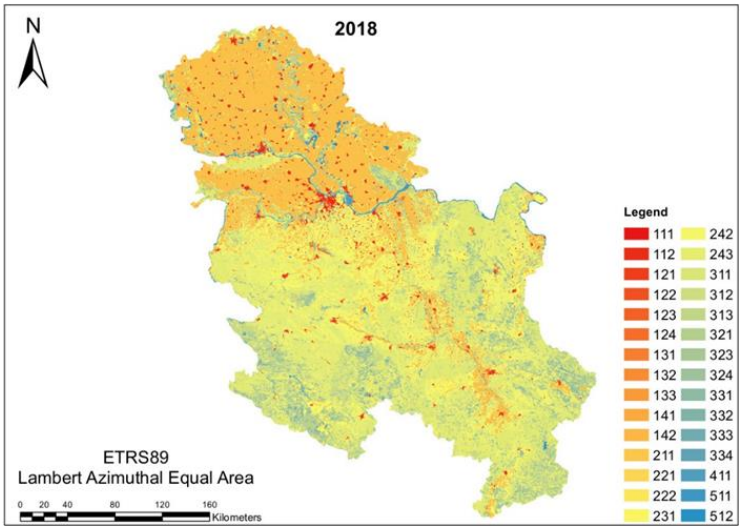

Figure 6. Thematic cartography concerning land-use changes in Serbia in year 2018

Table 3. Percentage of land-uses according to level 3 of CLC nomenclature in Serbia

CLC Code	1990	2000	2006	2012	2018	2018–1990
111	0,00%	0,00%	0,00%	0,00%	0,00%	0%
112	2,70%	2,81%	3,01%	3,02%	3,08%	0.38%
121	0,22%	0,24%	0,30%	0,30%	0,33%	0.11%
122	0,01%	0,01%	0,02%	0,02%	0,02%	0.01%
123	0,00%	0,00%	0,00%	0,00%	0,00%	0%
124	0,02%	0,02%	0,02%	0,02%	0,03%	0.01%
131	0,10%	0,10%	0,13%	0,14%	0,15%	0.05%
132	0,01%	0,02%	0,02%	0,02%	0,02%	0.01%
133	0,01%	0,00%	0,00%	0,01%	0,01%	0%
141	0,05%	0,05%	0,04%	0,05%	0,05%	0%
142	0,03%	0,03%	0,06%	0,06%	0,05%	0.02%
211	25,77%	25,85%	27,86%	27,86%	27,79%	2.02%
221	0,16%	0,15%	0,14%	0,13%	0,11%	-0.05%
222	0,16%	0,12%	0,32%	0,31%	0,40%	0.24%
231	2,46%	2,08%	2,15%	2,15%	1,97%	-0.49%
242	15,78%	15,85%	12,75%	12,74%	12,41%	- 3.37%
243	12,75%	13,00%	12,31%	12,29%	12,32%	-0.43%
311	26,59%	26,72%	26,79%	26,76%	26,79%	0.2%
312	1,05%	1,12%	1,24%	1,24%	1,25%	0.2%
313	1,48%	1,59%	1,68%	1,68%	1,78%	0.3%
321	2,88%	2,67%	2,65%	2,65%	2,56%	-0.32%
322	0,00%	0,00%	0,00%	0,00%	0,01%	0.01%
323	0,00%	0,00%	0,00%	0,00%	0,00%	0%
324	6,13%	5,87%	6,74%	6,79%	7,06%	0.93%
331	0,02%	0,02%	0,01%	0,01%	0,01%	-0.01%
332	0,00%	0,00%	0,00%	0,00%	0,00%	0%
333	0,26%	0,25%	0,25%	0,25%	0,25%	-0.01%
334	0,01%	0,01%	0,00%	0,01%	0,01%	0%
411	0,28%	0,32%	0,35%	0,34%	0,40%	0.12%
511	0,79%	0,78%	0,82%	0,82%	0,81%	0.02%
512	0,28%	0,31%	0,32%	0,32%	0,32%	0.04%

Table 4. Percentage of land-uses according to level 1 of CLC nomenclature in Serbia from 1990-2018

CLC Code	1990	2000	2006	2012	2018
1. Artificial surfaces	3.15%	3.28%	3.61%	3.64%	3.74%
2. Agricultural areas	57.08%	57.05%	55.54%	55.49%	55.01%
3. Forest and semi-natural areas	38.42%	38.25%	39.36%	39.39%	39.72%
4. Wetlands	0.28%	0.33%	0.35%	0.34%	0.40%
5. Water bodies	1.07%	1.09%	1.14%	1.14%	1.13%

In Table 2 and Figure 1, it is possible to analyze land-use changes in Serbia in detail. Let us consider the period between 1990 and 2018. The most significant difference occurs in CLC-242 (Land principally occupied by agriculture, level 2 Heterogeneous agricultural areas, and level 3 complex cultivation patterns) with a reduction of 3.37%. The next significant difference occurs in CLC-211(Non-irrigated arable land), increasing by 2.02%. The other significant difference corresponds to CLC-324(Transitional woodland shrub) with an increase of 0.93%. Finally, the fourth significant difference falls on CLC-112 (Discontinuous urban fabric), increasing by 0.38%. Besides these, we have CLC-313 (Mixed forest), CLC-222 (Fruit trees and berry plantations—CLC-121 (Industrial or commercial units, CLC-311 (Broad-leaved forest) and CLC-312) (Coniferous forest) with variations of 0.30%, 0.24%, 0.10%, 0,20% and 0.20%, respectively. On the other hand, it is also possible to identify important reductions in land use over the years in Serbia, as is the case of CLC-231 (Pastures) and CLC-243 (Land principally occupied by agriculture, with significant areas of natural vegetation)—and CLC-321 with decreases of 0.49%, 0.43%, and 0.32%. For a more accurate analysis of the results, thematic cartography was created for all the years the period 1990 to 2018.

4. Conclusions

Serbia is a country in Southeast Europe on the Balkan Peninsula. Once, it was part of Yugoslavia. It borders Hungary, Romania, Bulgaria, Macedonia, Kosovo (a partially recognized state in Southeast Europe), Albania, Montenegro, Bosnia and Herzegovina, and Croatia. Serbia has a warm-humid continental climate with cold, relatively dry winters and humid summers. The central part of the country is mostly hilly. The capital Belgrade is at convergence of the Sava and Danube Rivers. Dinaric Alps and the Carpathian Mountains stretch to the south and southeast. Mountainous areas are sparsely populated. In the north of country is the Autonomous Province of Vojvodina, part of the Pannonian Plain surrounded by the rivers Sava and Danube. It is part of country with most intensively developed agricultural production.

Dominant areas are areas with agricultural and pasture activities and forests. Agriculture is concentrated mainly in the north of Serbia and close to large rivers. Agricultural and pasture areas have decreased in recent years and have been most affected. Agricultural is the dominant class in 2018. Present 55.01% of the territory of Serbia (Table 2). Evident is the decrease in agricultural (2.07%) following the CLC database from 1990 to 2018. Forest area is increasing from 1990 with a variation of 1.3%, and in 2018 presented about 39.72% territory of Serbia. In areas that are protected under the Regional Network of Protected Areas or Natura 2000, the majority are part of forest areas. According to the CLC database, in the period 1990-to 2018, artificial areas increased in spatial coverage from 3.15 % to 3.74 %, and urban fabric from 2.70% to 3.08%. Due to the long delay in de-fining laws in the post-socialist period regarding the current urban policy, the current legal framework of the urban planning system and practices are not harmonized. This has led to uncontrolled growth in illegal and informal settlements in cities [31, 32].

The 1991-1999 civil war, the impact of climate change [33] and, changes in the agricultural sector since 2000, and other political and natural changes [34] led to a transition in arable land which will continue further after the restitution, most new owners retained the land but did not continue agricultural production. In addition, there is also a trend of newly built land on agricultural land. This statement is compatible with the known strategy of suburbanization in Central Europe, where the region of low-density housing is developing rapidly, albeit at a slow pace than in Western Europe (EEA, 2006). The progressive growth of empty land is related to the country's restitution and privatization process [35]. New residential areas tend to be built in "satellite" cities and villages near larger cities, existing infrastructure, and recreational areas [36].

Although planning solutions are unconditionally stopping the occupation of agricultural land for housing construction, industrial zones, the introduction of a ban on the expansion of construction areas of settlements in Serbia, and legislation prescribing measures and techniques of use, protection, and preservation of land resources. Nevertheless, the illegal and uncontrolled conversion of agricultural and forest land into construction land is widespread in Serbia, demonstrating that organizations and institutions of Republic of Serbia have challenges the in managing execution of legal acts [2]. The consequences of land conversion are the reduction of high-class land, especially the problem in Vojvodina, which is less and less like the former European granary. At the same time, it is the least suspicious. Also, a big problem is the conversion of pastures into arable land due to the increased need for arable land and their use for urbanization. All this has terrible consequences on increasing erosion and disrupting biodiversity.

The harmonization of legislation with EU legislation in all areas is a prerequisite for Serbia for EU accession, which when it comes to land management and conservation implies harmonization of the following legislation: Law on Forests, Law on Agricultural Land, Law on Regulation space, and construction, Law on Land Protection, Law on Environmental Protection, are just a few examples. The desired results can be achieved only with the previously defined goals of absolute protection of agricultural and forest land and desire to implement measures prescribed by laws that will be previously harmonized with European law.

Starting from the importance of increasing forest cover, a common goal is to upsurge area of national territory

under forests to 41.4% by 2050 [37]. Especially in the AP of Vojvodina, to increase area under forests in Vojvodina to 14.3% [38]. As a lowland granary of Serbia, Vojvodina has to increase its forest belt to protect soils from erosion, protection of infrastructure, and water system "Danube-Tisa-Danube." Territorial governance and spatial planning systems should intervene at different levels in these land-use development practices. The New Spatial Plan of Republic of Serbia 2021-2035 is the primary planning document for spatial planning and development in the state, which determines a long-term strategic framework for directing and managing spatial development. The essential determinations related to the planned changes in the fundamental purpose of space according to new The Spatial Plan of the Republic of Serbia 2021-2035 will be directed to adapting the purpose to natural conditions (afforestation) at the expense of lower quality agricultural land (VI and VII credit rating classes and land affected by erosion), around infrastructure corridors and sources of reservoirs, industrial zones, and suburban forests, as well as degraded areas (various tailings, abandoned mines, among many other examples) from the category of other areas. Besides, more rational use of previously occupied agricultural land and some restructuring in other areas [39]. It is carried out through regional spatial plans, spatial plans for special-purpose are-as, and urban plans. Therefore, there is a prerequisite to developing land-use strategies as an instrument to combine disciplinary knowledge with information on climate change, political change, and environmental factors [40-43].

5. Study Limitations and Prospective Research Lines

This quantitative assessment and mapping at national level can help Republic of Serbia and other countries better manage land use and planning policy and pre-pare activities to reduce degradation and define degraded areas and thus make a significant contribution to sustainability. Information on land use and change is collected from the CORINE Land Cover database. The Republic Bureau of Statistics forms its estimates using cadastral data and data from the 2012 Census of Agriculture [40].

Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

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