

## Article

# Depopulated and Abandoned Areas in Serbia in the 21st Century—From a Local to a National Problem

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**Abstract:** Depopulated or abandoned spaces are a consequence of the emptying of settlements and the complete disappearance of the human factor in the use of space. The aim of this paper is to determine the size and structure of this space—clusters that can be considered abandoned at the regional level. In the focus of this paper is the space at the district level in Serbia, within which significant changes in land use occurred in the period 1990–2018. Time series of formal databases and data obtained by GIS tools were analysed in order to observe the changes in the structure of surfaces and to define the trend of merging or increasing the empty space during the last two decades. This paper analyses planning documents and strategies in order to determine with which problems the state identifies abandoned areas and what planning solutions are possible. A new method for calculating the homogenization of abandoned space is presented. The results indicate the homogenization of the abandoned space in the border regions in the south of Serbia, as well as major changes in land use, such as reforestation and reclamation of agricultural land.

**Keywords:** depopulation; Serbia; region; land use; structure; analysis



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## 1. Introduction

The geospace in which Serbia is located today is characterized by great diversity in terms of geomorphological features, demographic and cultural conditions, and infrastructural equipment. It contains resources that man has been using since prehistoric times, and the spatial patterns of resource use have changed proportionally to bioclimatic conditions, with population growth, migrations and other factors. Nevertheless, the population permanently leaves certain regions, and they remain uninhabited. According to Saville [1], the causes of depopulation have not changed significantly in the last 150 years. The lack of jobs and the centralization of the economy in big cities, on the one hand, were at the heart of the problem of population decline, and the emptying of the countryside on the other. In addition, the alternative for agriculture was limited by low wages, which are related to the decreasing need for labour [2]. Rural areas include natural resources, such as water, land, and forests, so the abandonment of villages and the relationship to the rural environment should attract increasing interest in researching the process of depopulation in rural areas, socio-economic losses and the relationship between population and the environment [3]. Rural areas have an important role in scientific research, especially in modern times, in which one of the vital issues is the development of a geospatial complex outside the boundaries of urban areas [4]. However, it would be wrong to conclude that the causes of depopulation are exclusively economic in nature, since it also occurs in those areas that have the potential and favourable physical-geographical conditions for agricultural production. The non-economic variables of migration related to education, the feeling of belonging to the native region or the desire for experiences in the urban environment, although secondary, must not be neglected [5,6].

In addition, the traditional village is characterized by less favourable non-economic living conditions compared to cities. All the factors that lead to the decline in the number

of inhabitants in certain regions can be linked to the growing differences in the standard of living between them and other areas, especially in large cities [7]. As the young and educated population immigrates to the cities, the rest of the population has very little capacity to maintain the basic functions of the village, which also leads to spatial marginalization [8]. In the 21st century, rural areas are forced to face challenges such as globalization, climate change, urbanization, epidemics and population decline caused by insufficiently dynamic socio-economic development, and often degradation [9]. By 2030, abandoned land in the European Union is expected to reach 5.6 million hectares, which is 3% of the total arable land [10].

Rural, mountainous and border regions in Europe are among the most threatened by the processes of deagrarianization and depopulation. The northern parts of Sweden have been facing rural depopulation since the late 1970s [11]. Research has shown that one of the main causes of this trend is the departure of young people to universities in large city centres, and the fact that they do not return to their hometowns after finishing school [12]. The idea of the central authorities was to improve the quality of human capital in rural areas through cheaper education [13]. However, when making such a decision, the fact that people with higher education are more willing to migrate in search of work [14], and that the labour market is larger and more diverse in cities [11], was not taken into account.

When attempting revitalization, the focus is on compensation and slowing down the process with the initial assumptions that depopulation is a natural process and further urbanization is a step forward in development [15]. Recognition of any value that depopulated areas continue to have, other than mineral resources, is almost non-existent by national policy makers [16]. This should not exclude further research into settlements where the last inhabitants struggle with the problems brought not only by nature (climate change, wild animals and reforestation) but also society (lack of basic functions). Scientists' interest in this topic dates back to the first half of the 20th century, but it intensified after the Second World War, culminating in the last two decades [17]. Abandoned land can be defined as land that was previously used for various purposes (agriculture, forestry, mining, industry, etc.) and is no longer used but has not yet been converted into forests or artificial areas. In research on abandoned land, two prognostic directions appear: the first one indicates problems (loss of biodiversity, increase in invasive species, soil erosion) and the second indicates benefits (increase in non-farming biodiversity, opportunity for ecosystem restoration, increase in water quality and quantity, increase in individuals of large mammals, etc.) [10]. The size, structure and location of abandoned land are important for assessing the local effects on neighboring regions and adapting policy interventions [18]. In the case of marginalization and abandonment of arable land, the regeneration of natural vegetation is a locally determined process. Measuring the size of the area with this process makes it easier to predict in which space-time frame the complete transition of previously cultivated land into natural vegetation (e.g., forest) will occur. In rural areas, arable land that is cultivated for a long period of time is particularly important, and once abandoned, it affects the environment, and re-cultivation is a very expensive process. Therefore, determining the location and size of abandoned land is the basis for a risk map for investments in rural areas. Agricultural land is important and essential for food production, which is why the prevention of land abandonment is a component of food security. With the non-use of land for food production, the country becomes dependent on external food markets. Thus, although it constitutes a small part of the budget of rural communities, agriculture has great political power [19]. In the case of Europe, the policy of revitalization of abandoned land and rural communities (Common agriculture policy) has four extreme scenarios for the period 2021–2027 [10]: productivism, neoliberalism, multifunctionalism and ecosystem revitalization. The first foresees the stimulation of agriculture in abandoned but highly productive areas with price support, financing of equipment, etc. The second involves giving up any support from the state and leaving the land and abandoned spaces to the rules of the free market, leaving public institutions to private owners. The third direction stimulates a diversified economy without supporting agriculture. The fourth direction implies leaving

previously cultivated areas to spontaneous reforestation and directing farmers to engage in other activities. The abandonment of rural areas and agricultural farms in the Carpathians of Slovakia, the Czech Republic and Poland [20] and western Ukraine [21] could be of importance for research into the same phenomena in Serbia. Namely, all the listed countries had a socialist system until the 1990s of the last century, so drawing parallels between these countries would help in understanding the role of state policies and institutions in changing land use and abandoning it. Those factors, although they are constant or change over very long time intervals, are very important for making decisions about land use and determine the profitability of agriculture [22,23]. The transition in Eastern and South-eastern Europe offers opportunities for experimentation, that is, the study of large-scale determinants, which is a rare and interesting phenomenon. Kuemmerle et al. [21] note that most Eastern European countries implemented land reforms with the aim of privatizing land, dissolving cooperatives and encouraging private entrepreneurship. Nevertheless, these processes, combined with stronger competition after the opening of borders for the market of Western countries, have led to the stagnation of agriculture, the abandonment of agricultural land in post-socialist countries and the departure of young people to the cities [21,24].

The goals of our work were to investigate: (1) the size of abandoned space (at levels NUTS2 and NUTS3) and the number of abandoned clusters (homogenization index), (2) changes in land use in abandoned spaces in Serbia in the period 1990–2018, and (3) the possibility of further use of space and resources. The initial hypothesis was that in the processes of emigration, aging of the population and increased mortality, the rural area of Serbia gradually lost its economic functions, as well as the restoration of natural vegetation. The expected hypothesis was that abandoned settlements gradually grow together creating a homogeneous empty space—an abandoned cluster (K0). In addition, it would be expected that there would be a homogenization of the used areas, especially deciduous forests and transitional woodlands, the area of which increases at the expense of cultivated land. With the increase in the area with natural vegetation, the restoration of the habitat and the increase in the fauna fund gradually occur. For the purposes of the research, a new methodology for the clustering of abandoned spaces was tested. In this framework, the sustainability of the rural area is impaired due to the absence of man and a traditional economy, which raises questions for the further use of resources.

## 2. Literature Review

The causes of the appearance of depopulated areas around the world are numerous. The globalization of the economy, as well as the social and cultural processes that accompany it, have made young people less and less dependent on the opportunities provided by the settlement or region in which they were born [25]. Although the role of the process of globalization and urbanization in the creation of depopulated areas is obvious, it should be emphasized that the factors that cause rural depopulation are specific to each country. Some authors distinguish between two types of depopulation: the traditional type of depopulation in areas where the main reason for population loss is a negative migration balance, and the so-called new type caused primarily by negative natural growth [26]. The departure of the population from rural areas is often explained by the stagnation of agriculture, in cases where it does not have an intensive and market-oriented character, and therefore does not provide enough income for farmers and their families. On the one hand, such a state of this economic branch may be a consequence of unfavourable geomorphological and pedological characteristics and climatic characteristics of the area, which make production difficult and reduce yields. On the other hand, obstacles in improving agriculture are related to the age profile of the rural population. The older population has a harder time accepting new technologies and is reluctant to hand over control of property to younger and more capable household members [27], resulting in the departure of the young and ambitious workforce.

Various studies have been conducted throughout the Mediterranean, most often with the aim of quantifying the abandonment of agricultural land in mountainous areas.

Depopulation areas were identified as early as the 1920s, but their more intensive study began in the second half of the 20th century, especially in Spain [28–31]. The area of these abandoned areas is up to 40% of the total agricultural areas in La Cabrera (Province of León) [32], 50% in Asturias [33] and 80% in Valdesamari [34]. Badia et al. [35] found that 36.4% of cultivated land in Catalonia was abandoned. In northern Portugal (Rio Coa), 80% of the areas that were once under cereals are no longer cultivated. In Italy, research emphasis was placed on the Alps and partially on the Apennines [36,37], while in Greece they studied the abandonment of agricultural terraces [38,39]. There are depopulation areas outside of Europe, and an interesting example is Japan. Namely, Moore [40] believed that Japanese rural areas are more resistant to depopulation changes due to the existence of fishing cooperatives, which provided a stable income from several economic activities of the primary sector. However, Barrett & Okudaira [41] note that large parts of this far-eastern country, especially the island of Honshu, are facing environmental degradation, resource depletion and rural depopulation. Liaw [42] argues that migration is a consequence of the lack of “economic and educational opportunities for the local population”. Recent studies [43] have proven that demographic changes in the rural areas of Japan affect the importance of agriculture in the economic structure and the accumulation of capital.

The size, structure and location of abandoned land has been studied from several aspects and using different methods. Verburg and Overmars presented an adapted version of the Dyna-CLUE model, which is based on the spatial allocation of the need for specific land use types within individual grid cells. The model was applied to Europe and indicated the area and spatial distribution of abandoned land (representation mainly in regions with relatively modest conditions for agriculture such as mountainous areas) [44]. Using the MODIS NDVI time series, the size of abandoned land relative to cultivated land in Central and Eastern Europe was studied by Alcantara et al. [45]. Their findings indicate 52.5 million hectares of abandoned land in the temperate zone of this region, mostly in Russia, Belarus and Ukraine. Serbia is ranked among the countries with a moderate percentage of abandonment (6%) [45]. Perpina Castillo et al. [18] calculated area and structure using the LUISA model, which includes multiple factors classified into three groups: biophysical, socio-economic and demographic-geographic. Each factor corresponds to a thematic layer or statistical information at the regional level. They came to the result that by 2030, 5.6 million hectares will be abandoned and more than 183 million hectares of land in Europe will be at high risk of abandonment and not exclusively in mountainous areas [18]. Kitano used a regression model to establish the determinants of farm abandonment in Japan. He noticed that the more arable land there is in a certain region, the greater the chance that certain plots will be abandoned. He also concluded that a well-functioning land market prevents land abandonment [19]. Kiziridis et al. [46] analysed several sites in Greece that, due to abandonment, are experiencing a land cover transition. For each site, they measured the area, diversity, spatial aggregation, etc. They concluded that the expansion of forests over farms and pastures leads to a decrease in diversity [46].

From a spatial point of view, depopulation first affects villages and then cities in mountainous and border areas. This pattern is observed in certain parts of Europe: northern Sweden, the Spanish Meseta, Lapland, the Central French Massif, the Apennines, the Alps, the Czech Sumava and the Carpathians [28,37,47]. Depopulation and emigration from certain rural regions of Serbia were pointed out by geographers and other scientists as early as the beginning of the 20th century. The demographic imperative was emphasized through the departure of the young population to the cities for employment and a more comfortable life. The decline of the young, fertile population was also associated with a lower need for labour in the countryside (in agriculture, forestry and manufacturing), especially during socialism. However, the causes of leaving the countryside can also be found in the general political instability in which Serbia was involved. It is also related to the frequent wars that Serbia, and later Yugoslavia, fought several times during the 20th century. At that time, the rural population in the border areas of Serbia especially suffered great human losses. The demographically weakened rural area has become unique in its inability to

compensate for the young population through immigration or natural increase [48]. The limiting factor of rural economic development is the unfavourable educational structure of the rural workforce (28% without formal education, 27% primary education and 36% secondary education) [4]. Developed European countries lose about 1.5% of their rural population annually, which reduces arable land and the number of farmers, as well as changes the structure of production. A similar trend was recorded in the territory of the South Morava River basin. In the South Morava basin (Southern Serbia), in the period 1961–2011, the number of inhabitants decreased on average by 0.87% per year, agricultural land decreased by 1.2%, and arable land by about 1% per year [43]. After more than a century, depopulated areas are being investigated as a process that can lead to problems in the ecological, economic and sociological domain of the region and the country. Research into abandoned villages in Serbia was carried out in the direction of identifying geographic, demographic and economic factors that led to their emptying. The natural and functional patterns of spontaneously displaced settlements in Serbia, as well as the regions where such settlements occur, have been established [49–58]. Among the spontaneously displaced settlements in Serbia, some were also spontaneously populated in some period of history. This especially applies to settlements that were created as a result of forced migrations, escapes and hiding. Displacement and the disappearance of the rural economy should also be seen as a natural process due to the cessation of the population's need to live in them, that is, the need to live in other areas.

### 3. Methodology

Abandoned space in Serbia has been identified in several regions: 1. belt of Central Serbia along the administrative line towards Kosovo and Metohija, 2. border belt towards Montenegro, 3. southeast of Serbia, 4. southern rim of the Stara Planina mountain [59]. According to the 2011 population census, 225 settlements had less than 20 inhabitants, and 98 villages in Serbia had less than 10 inhabitants [60].

The cadastral municipality with less than 20 inhabitants was chosen as the basic unit for the analysis of several factors of abandonment, because it is a territorial unit that, as a rule, covers the area of one inhabited place. The largest number of cadastral municipalities, which are part of this research, had one settlement. The borders of the cadastral municipality are geometrically defined and geodetically described (coordinates).

We accepted and modified the typology that links the abandonment of villages and changes in land use [61]. The modification was made by introducing the number of inhabitants for a certain type:

1. Recent abandonment (RA)—the farm is not used. Cultivated plants are replaced by natural vegetation depending on climatic and pedological characteristics (cadastral municipalities with 10 or fewer inhabitants).
2. Neglect or hidden abandonment (N)—the land is not formally abandoned and there are some forms of management. The farm is used extensively for social reasons or is intended for other functions such as storage or tourism (cadastral municipalities of 11 to 20 inhabitants).
3. Transitional abandonment (TA)—caused by agricultural restructuring and land reforms (more than 20 inhabitants). In the case when two or more cadastral municipalities merge into a common space, we can consider such a phenomenon as an abandoned cluster (C0). For the purposes of this work, we proposed the *homogenization index* of the abandoned space (A0). We designed the homogenization index as a simple indicator that will quantitatively show the dominance (pattern) of abandoned land in relation to other land in a certain territory (e.g., in the administrative areas of a country). We studied abandoned clusters as islands where vegetation regenerates without human influence. The homogenization index is calculated according to the following equation:

$$A0 = N_{C0} \div N$$

where  $N_{C0}$  is the number of abandoned clusters and  $N$  is the number of abandoned cadastral municipalities. The closer the index is to 1, the greater the homogenization. In anticipation of the census at the beginning of the third decade of the 21st century, data on changes in space and surface use were provided by GIS databases. The Copernicus Land Monitoring System databases for 1990 and 2018 were used in the form of high-resolution thematic maps. The Global Mapper v.18 application and adequate tools for the analysis of vector surfaces were used to process the maps of the used areas (Land Cover). The official database on illegal logging and fires of the public forests company 'Srbijašume' contributed to the analysis of the sustainability of forests in abandoned areas. The mentioned methodology and techniques are quantitative in nature. Despite their advantages, they cannot fully depict the consequences of the abandonment of settlements in Serbia. Among the objective methodological problems, such as the delay in conducting a new population census, there are also the subjectivity of the methods used in terms of the selection of settlements that have not been completely emptied (they are on the verge of disappearing).

#### 4. Results

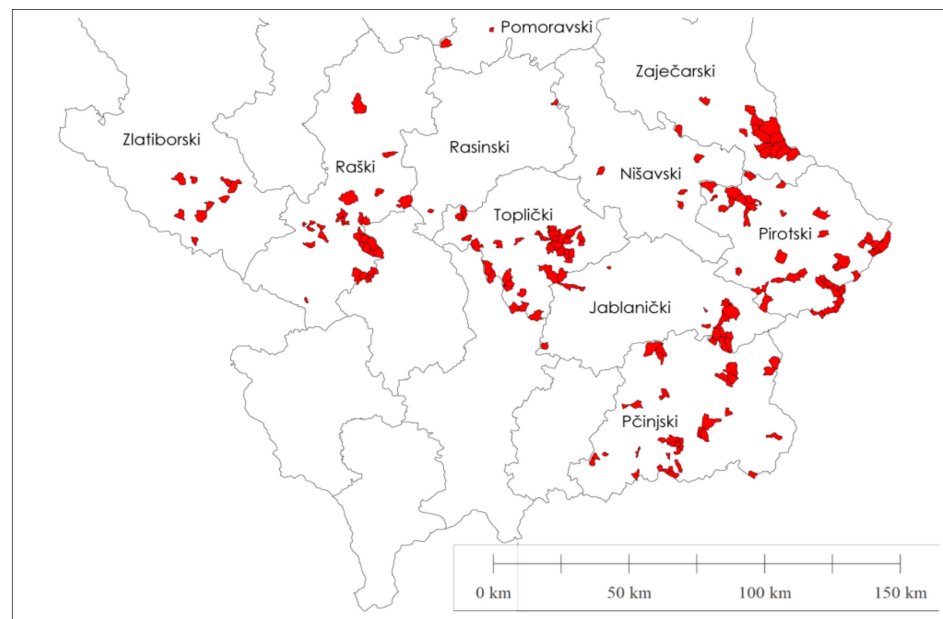
According to the methodology used to identify abandoned areas [61], in Serbia we identified 10 districts with 197 cadastral municipalities, among which there were the most of those from the categories Recent abandonment and Neglect or hidden abandonment. There were 29 completely abandoned cadastral municipalities. The seemingly irreversible process of abandonment of settlements and abandonment of arable land was present south of  $43^{\circ}53'$  N or the parallel that roughly intersects cities Užice, Čačak and Paraćin (Figure 1). The first goal of the work was to determine the area of the abandoned space. The total depopulation area was  $1540.86 \text{ km}^2$ , which is approximately half of the territory of the capital (Belgrade) or about 2% of the total area of Serbia (without the territory of the statistical region of Kosovo and Metohija). As a percentage, it covered 3.68% of the NUTS2 region of Šumadija, West, East and South Serbia. At the NUTS3 level (districts), the highest representation of abandoned space in relation to the area of the district was in Toplički (12.8%) and Pirot district (11.5%) (Table 1). The average population density in the abandoned/neglected area of Serbia is 2 inhabitants/ $\text{km}^2$ . The lowest was in Zlatiborski (0.71 inhabitants/ $\text{km}^2$ ) and the highest in Rasinski district (5.69 inhabitants/ $\text{km}^2$ ). It is expected that the results of the first census in the third decade of the 21st century will indicate an even greater decrease in population density and the disappearance of the population in certain cadastral municipalities. Such population density is typical for the desert or polar regions of our planet.

In Serbia, thirty-two clusters of abandoned space were identified in seven districts. The number of abandoned cadastral municipalities in one cluster ranges from two (in several districts) to sixteen (Toplički district—Pasjača mt.). The single largest cluster was located in the municipality of Knjaževac in the Zaječar district. It has an area of  $155 \text{ km}^2$  where 82 inhabitants lived (0.52 inhabitants/ $\text{km}^2$ ). The homogenization index of abandoned space ( $A_0$ ) in Serbia was 0.15. By district,  $P_0$  was as follows: Zlatiborski 0.22, Raški 0.18, Toplički 0.16, Zaječarski 0.14, Pirotski 0.15, Jablanički 0.12, Pčinjski 0.22 (Figure 2). The greatest homogenization of abandoned cadastral municipalities was found in the mountain area of Rogozna (Raški district), Pasjača, Radan (Toplički district), Stara Planina (Zaječarski district), Visok, Vidlič, Svrljiške mt., Vlaška mt. (Pirotski district), Čemernik (Jablanički district) and Široka mt. (Pčinjski district).

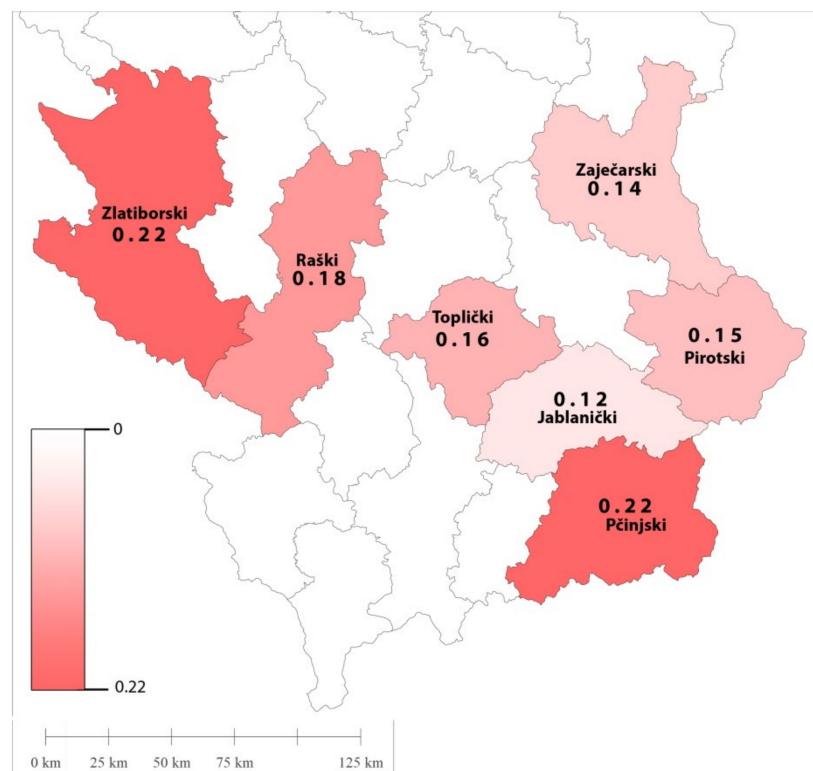
**Table 1.** Statistical indicators of abandoned territory in Serbia at the district level.

District	Total Land Area (km <sup>2</sup> )	Total Population 1991	Total Population 2011	N	N <sub>CO</sub>	A (km <sup>2</sup> )	%A of the District (km <sup>2</sup> )	D (inh/km <sup>2</sup> )	Land Use Change 1990–2018 (%)								
									1	2	3	4	5	6	7	8	9
Zlatiborski	6140	335,826	286,549	9	2	83.37	1.35	0.71	−1.5	−2.0	−4.2	−2.3	32.7	10.9	−9.7	−58.8	150.5
Raški	3923	300,274	309,258	33	6	224.91	5.74	2.66	−3.8	−17.7	15.9	−20.1	−6.4	37.4	91.8	91.8	−48.3
Rasinski	2668	283,108	241,999	2	0	5.8	0.21	5.69	7.9	24.6	0.0	−26.1	-	-	-	100.0	0.0
Pomoravski	2614	264,108	214,536	2	0	12.51	0.47	2.88	0.1	47.6	100.0	−96.5	-	-	-	100.0	−78.3
Toplički	2231	111,813	91,754	36	6	285.64	12.8	1.68	−1.6	−49.7	123.7	−24.0	−33.3	13.4	−11.4	−78.1	6.3
Nišavski	2728	396,043	376,319	4	0	23.62	0.86	1.65	−1.3	1.2	35.5	−16.5	-	100.0	0.0	−100.0	0.0
Zaječarski	3624	158,131	119,967	14	1	204.84	5.65	0.65	0.5	−66.4	12.0	−29.6	62.1	60.8	54.1	-	-
Pirotski	2761	116,926	92,479	46	7	318.39	11.53	1.35	−0.2	−37.4	33.2	−26.1	1114.0	252.8	−7.9	11.2	29.4
Jablanički	2770	255,011	216,304	16	2	122.35	4.41	1.14	−38.9	−64.1	0.5	−11.1	−42.5	8.1	55.0	−74.6	−14.2
Pčinjski	2761	243,529	159,081	35	8	259.43	7.37	1.56	17.9	24.3	−9.9	−31.9	727.9	303.2	7.1	1.8	120.3
Total/average:	32,979	2,464,769	2,108,246	197	32	1540.8	1.98	2.00	−1.1	−34.6	19.7	−20.5	24.2	67.8	−55.1	−0.7	−15.1

Source: Public forest company “Srbijasume”—JPS [62] Statistical Office of The Republic of Serbia—SORS (2014) [63] independent data processing Corine Land Cover (EEA—European Environment Agency); N—number of abandoned floors. Municipality, N<sub>CO</sub>—number of abandoned clusters floor municipality, A—total area of abandoned space, %A—share of abandoned area in the total area of the district, D—population density of abandoned space; classes of used surfaces (1—Broad-leaved forest, 2—Land principally occupied by agriculture, 3—Transitional woodland, 4—Complex cultivation patterns, 5—Coniferous forest, 6—Mixed forest, 7—Natural grassland, 8—Non-irrigated arable land, 9—Pastures.



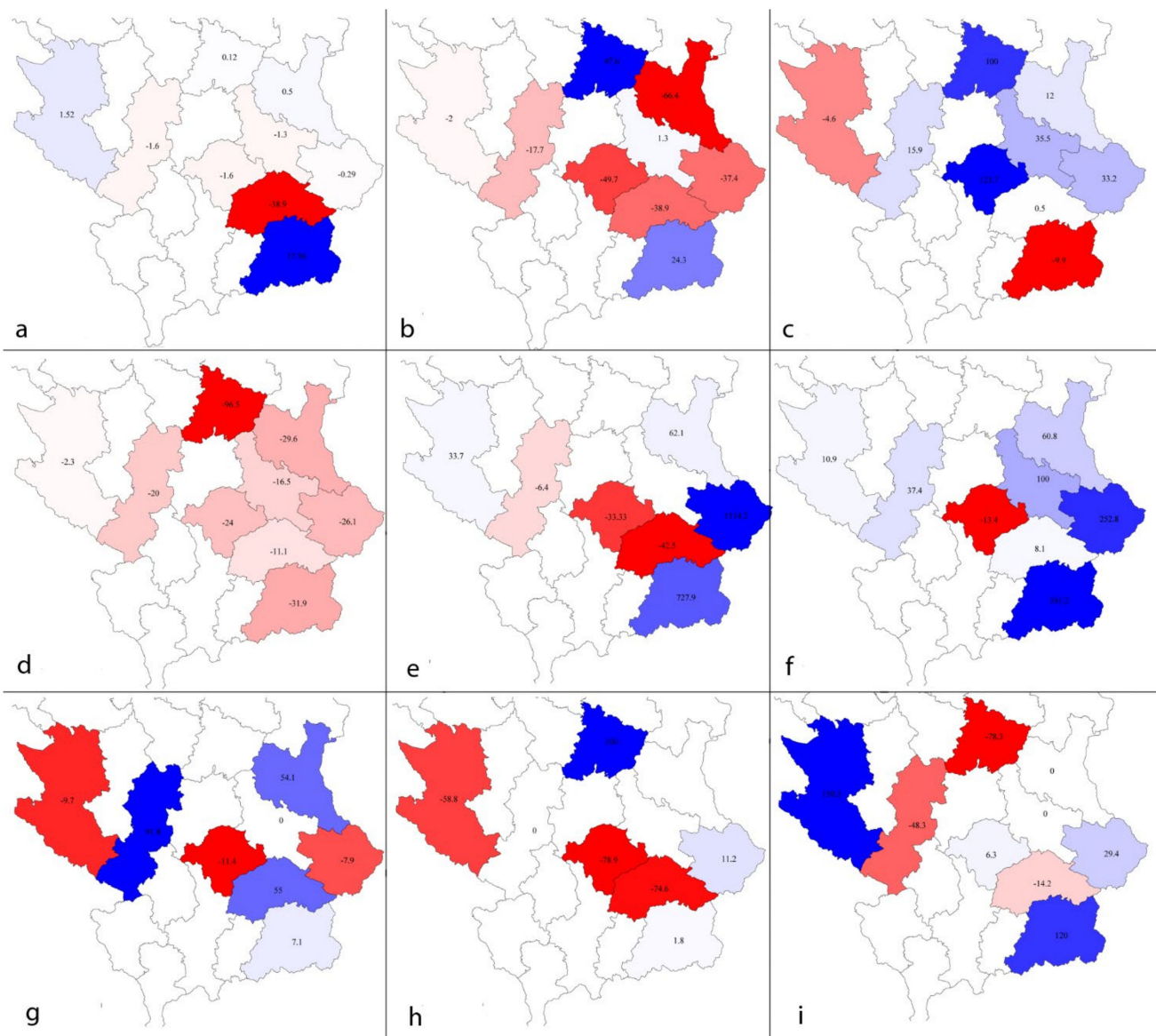
**Figure 1.** Depopulated areas (with 20 or fewer inhabitants in 2011) by districts of Serbia.



**Figure 2.** Index of homogenization of abandoned space (A0) by districts in Serbia.

The results of the spatial data analysis (Copernicus Land Monitoring System for 1990 and 2018) indicate significant changes in the used area. In the mentioned period, there was a significant increase in bushy vegetation, pastures, coniferous and mixed forests on the one hand (regrowth process), as well as a decrease in the area of arable land, gardens and orchards, and rocky areas on the other (Table 1, Figure 3). The reduction in cultivated areas accelerated after the settlement was emptied. We analysed the changes according to land use class.





**Figure 3.** Increase and decrease in the classes of the land use in percentages 1990–2018 (%). Explanation: (a)—Broad-leaved forest, (b)—Land principally occupied by agriculture, (c)—Transitional woodland, (d)—Complex cultivation patterns, (e)—Coniferous forest, (f)—Mixed forest, (g)—Natural grassland, (h)—Non-irrigated arable land, (i)—Pastures.

1. Broad-leaved forest—(decrease from 918.8 km<sup>2</sup>—1990 to 908.1 km<sup>2</sup>—2018: decrease of 1.1%). The largest growth of deciduous forests was in the abandoned areas of the Pčinski district, and the largest decrease was in Jablanički, where problems with illegal logging occur. The average minimum reduction in areas under deciduous forests is a consequence of the exploitation of firewood and technical wood, especially from the territory of villages on the Pasjača, Radan and Rogozna mountains—along the administrative line with Kosovo and Metohija. In the Land Security Zone (LSZ), a so-called military belt around the administrative line of Central Serbia towards Kosovo and Metohija, which has a special status, the largest illegal forest cutting in Serbia occurred during the last 22 years. On the territory of forest state properties (Leskovac, Vranje, Raška, Kruševac and Kuršumljija), which also include abandoned areas in the Jablanički, Toplički, Raški and Rasina districts, in the period 1999–2021, 688.15 m<sup>3</sup> of forest was illegally cut down. In the period 2015–2020 in forest properties, which also include abandoned clusters, 90,751 m<sup>3</sup> (73% of the total illegally cut forest

in Serbia) was illegally cut, 6604.82 ha (52% of all areas in Serbia) was affected by fires, and the total number of forest fires was 245 (50% of all fires in Serbia). In the same period, the frequency of forest fires increased from an average of 18 (2015–2016) to 52 (2017–2020) [63].

2. Land principally occupied by agriculture (decrease from 153.3 km<sup>2</sup> to 100.1 km<sup>2</sup>: decrease of 34.6%)—this category is experiencing a decline due to the abandonment of villages. In three districts, an increase in the area of this class was recorded, even though the villages were emptied. Cultivation of land in the Rasina, Pomoravski and Nišava districts, although depopulation has occurred, is a consequence of the leasing and cultivation of land by residents from other cadastral municipalities. In other districts, a decline was recorded due to the abandonment of the traditionally basic form of economy, mostly vegetable growing, fruit growing and wine growing. Data from the field show that once cultivated areas are gradually turning into transitional woodland.
3. Transitional woodland (increase from 242.8 km<sup>2</sup> to 290.7 km<sup>2</sup>: increase of 19.7%)—areas with bushy vegetation that supplants previously cultivated areas are increasing in almost all abandoned areas in 8 out of 10 districts. The biggest increase was in the Toplički district, which had the largest area of abandoned land. The correlation of the abandoned area with the growth of this class is significant and indicates permanently abandoned cadastral municipalities.
4. Complex cultivation pattern (decrease from 88.5 km<sup>2</sup> to 70.3 km<sup>2</sup>: decrease of 20.5%)—this class is traditionally very represented due to fragmented holdings typical of mountain villages in Serbia. After the abandonment of the village and the decline of agriculture, this class was in decline the most in the villages of the Pomoravski district where the population in the past was engaged in vegetable and arable farming. Zlatiborski and Jablanički districts recorded the least changes due to the large share of villages where animal husbandry was the dominant branch of agriculture.
5. Coniferous forest (increase from 30.5 km<sup>2</sup> to 37.9 km<sup>2</sup>: increase of 24.2%)—a class that is represented mostly above 1,000 m and, therefore, does not extend in all the investigated districts. The largest growth of coniferous forest was recorded in the Pirotski and Pčinjski districts, which is a consequence of the overgrowth of meadows at the highest forest belt. The largest decline in the area under conifers was recorded in the Jablanički district, which is a consequence of the already mentioned forest cutting and fires that affected the villages along the administrative line with Kosovo and Metohija.
6. Mixed forest (increase from 32.3 km<sup>2</sup> to 54.2 km<sup>2</sup>: increase of 67.8%)—this class recorded growth in abandoned areas of all districts where it appeared. Most often, it comprises mixed forests of beech, hornbeam, spruce and fir at the upper border of deciduous forests and the lower belt of coniferous forests. Mixed forests had the greatest growth in the same districts as conifers (Pirotski and Pčinjski). The smallest increase was recorded in the Jablanica and Toplica districts, which face illegal logging.
7. Natural grassland (decrease from 87.4 km<sup>2</sup> to 39.2 km<sup>2</sup>: decrease of 55.14%)—are perhaps the most important arable areas in abandoned villages, because most meadows were oriented towards cattle breeding. After the abandonment of animal husbandry, natural grassland grew into transitional woodland and similar classes. Natural grassland experienced an increase in areas where there was no growth of forest and transitional woodland, while agriculture land decreased (example of abandoned areas in Raški, Zaječarski and Jablanički districts). Natural grassland expanded across fields, orchards, vineyards and other previously cultivated land.
8. Non-irrigated arable land (decrease from 6.7 km<sup>2</sup> to 6.6 km<sup>2</sup>: decrease of 0.7%)—no significant change in these surfaces was recorded. In the researched clusters, due to the fact that the soils in the mountain lands are generally not irrigated, this class of land occupied a very small area. The largest increase in such areas was recorded in Pomoravski district and the largest decrease in the Jablanički and Toplički districts.

9. Pastures (increase from 32.6 km<sup>2</sup> to 37.6 km<sup>2</sup>: decrease of 15.1%)—is a category of natural areas under grass that were used by herders in high mountain villages. The expansion of natural pastures is limited or stimulated by the ecological conditions required by the specific grass species that make up the pastures. The increase in pastures is primarily due to natural bioclimatic factors in the last 30 years, such as an increase in average air temperature. The decrease in pastures is the result of overgrowing certain areas with shrubby and forest vegetation.

The results confirm the initial hypothesis that the process of emptying rural areas caused the reduction in arable land and the growth of forests and transitional woodlands. In addition, the expected hypothesis that the abandoned spaces grew together creating a homogeneous space was partially confirmed. That process appeared in seven of the ten counties studied where we expected it to be proven.

## 5. Discussion

Intensive depopulation of rural areas in the Republic of Serbia began after the Second World War. On the one hand it was caused by soaring industrialization and city growth, processes which attracted a large amount of the rural population, and insufficient concerns for the rural and agricultural development on the other. Villages located in the hilly and mountainous areas, which were characterized by a young and demographically vital population in the middle of the 20th century, during the next 50 years had been transformed into “old age homes”, particularly with the absence of the process of natural renewal of the population. This process eventually led to the complete demographic extinction of some villages. The first two villages with no inhabitants were statistically registered in the 1991 Census. According to the results of the 2002 Census, the number of officially abandoned villages (excluding the territory of Kosovo and Metohija) increased up to six, and in 2011 Census up to thirteen [60]. The next population census in Serbia (originally planned for 2021 and postponed to October 2022 due to the pandemic of the COVID-19 virus) will undoubtedly confirm the accelerating trend of total depopulation of numerous villages, whose demographic sustainability is extremely unrealistic [64].

However, the number of completely abandoned villages in Serbia is undoubtedly higher than the one shown in the population censuses. For example, visiting the isolated mountain regions of southern and eastern Serbia during the 2009 revealed the existence of 20 spontaneously abandoned settlements, which is significantly more than the then-official number. The main reason for this occurrence lies in the abandonment during the years after the census, but there are also cases of so-called “statistical invisibility”, which are the result of the fact that population censuses in Serbia are based on the officially registered place of residence [55]. In other words, there are villages that are “de facto” abandoned, but “de jure” they are not. This happens because their last inhabitants were moved out but are still officially registered as residents of those settlements.

Almost all of the abandoned villages in Serbia are located in mountainous and border areas, whose basic demographic features are very low population density, extremely negative natural increase, extremely low birth rate and the stage of the deepest demographic age (average age over 60 years, and in some cases over 80). Such processes are the most pronounced in southern and eastern Serbia, where the extent of depopulation process is so severe that abandoned villages are no longer isolated geographical points, but rather their areas are growing together forming continuous homogeneous spatial units—clusters, which are identified in this paper.

In this section, we will emphasize the most important factors which led to the depopulation and extinction of rural settlements in the Republic of Serbia: the desire for education and professional development, the attractiveness of life in the city, industrialization, insufficient investments in the development of the countryside and agriculture, bad state of communal infrastructure, the absence of public service facilities, distance from the main roads and morphological inaccessibility. Regarding to these factors, the abandonment of the villages in Serbia does not differ so much from similar processes in other European

countries. However, there were also other processes typical only for certain settlements and localities. As examples, we will emphasize case studies of the following villages: Gabrovnica, Vukojevac and Koritnjak.

Gabrovnica in the municipality of Knjaževac (Zaječarski district), is located on the western slopes of the Stara Planina (Balkan mountain). The recent history of Gabrovnica relates to the controversial Yugoslav nuclear project [65] and the attempt of nuclear bomb creation carried out by the communist authorities [66]. At the beginning of the 1960s, a uranium mine was opened in the village, and the mine zone and its surroundings were declared as a prohibited zone protected by the state [50]. However, due to economic unprofitability, the mine was closed in 1965. The cessation of mining activity largely determined the further demographic processes of Gabrovnica [52]. In the decade 1961–1971 the number of inhabitants decreased from 603 to 201. In addition to the economic reasons, the fear of possible radiation was also an important factor that accelerated the abandonment of the village. Measurements made in the vicinity of the mine have shown increased levels of radioactivity, but their impact on human health has not yet been sufficiently investigated [67–69]. According to the 2011 Census, Gabrovnica had only three inhabitants, with an average age of 79.8 years [70].

Vukojevac in the municipality of Kuršumljija (Toplički district) is located on inaccessible mountain terrain (780–860 m above sea level) on the administrative line between Central Serbia and Kosovo and Metohija. The village reached its peak in the number of residents in 1953, when it had 260 inhabitants, after which a process of rapid demographic drain began. The last resident left in 1985, when Vukojevac became the first completely displaced village in Serbia [53]. The state's forestry company bought all the abandoned land and properties in order to prevent the possibility of selling the land to Albanians from the neighboring municipality of Podujevo in Kosovo and Metohija. However, even after the sale of the land, resettled residents retained the ownership of the houses. Later on, those houses were sold to the Albanians from Podujevo; the houses were demolished and the construction materials were transported to the municipality of Podujevo and reused for building new houses [71,72]. Nowadays, in relation to the other abandoned villages in Serbia, Vukojevac is the only one without single building in it, even the foundations of the houses were taken away. With the abandonment of Vukojevac and the neighboring villages of Tačevac (zero inhabitants in 2011) and Rastelica (three inhabitants), a distinct demographic asymmetry has been created between the densely populated Podujevo's villages with an Albanian population (about 150 inhabitants/km<sup>2</sup>) and the almost empty space on the Kuršumljija side of the administrative line (about three inhabitants/km<sup>2</sup>). Since the arrival of international peacekeeping forces in Kosovo and Metohija in 1999, the village has been located in the so-called "Security zone", which includes a demilitarized buffer zone—5 km from both sides of the administrative line. Although the Serbian police returned to the "Security zone" in 2001, a security vacuum has been created, since the control of the administrative line is very difficult due to the lack of quality roads and uninhabited areas. Armed Albanians from villages in the municipality of Podujevo invaded the abandoned areas of Vukojevac, and misused this situation for illegal logging and the sale of stolen wood. The Serbian army and police very often fail to detect and prevent these occurrences, and sometimes it comes to armed clashes. For all those reasons, nowadays Vukojevac is an area of high security risk.

Koritnjak, in the municipality of Niška Banja (administrative region—City of Niš), is distanced only 4 km from the Belgrade-Sofija-Istanbul highway (branch C of the Pan-European corridor 10), 3.5 km from Niška Banja spa and 11 km from the city center of Niš. At first glance, proximity to international roads and urban centers classifies Koritnjak in the group of suburban settlements, which are attractive for housing [73]. However, unlike the neighboring rural settlements, in the case of this village, the positive development effects of Niš and Niška Banja spa were completely absent. This implies the conclusion that, for the purpose of modern housing, not even favorable socio-economic factors were sufficient to overcome the following natural limitations of Koritnjak village: position at

the top of a hill and very steep terrain [55], which actually makes it isolated and very difficult to approach. After the Second World War, in the time of intense industrialization and urbanization, the authorities assessed that Koritnjak was a village with no perspective and that all investments would be unprofitable. Koritnjak never received electricity, water supply, sewerage and telephones [74]. The village was left with no inhabitants in 2002. Koritnjak had an ironic destiny—an asphalt road to the village was built after the last man died. It was built for the purpose of international paragliding sport events, which are being organized in the village area. This makes Koritnjak very attractive for the development of tourism, but due to the lack of investment, there are currently no concrete measures for the development of tourism.

The abandonment of space in Serbia can be also interpreted out of the framework of well-known socio-economic factors (urbanization, industrialization and deagrarianization). The majority of abandoned settlements nowadays, in Serbia, are located in source areas of mountainous streams or in steep valleys with slopes larger than 20 % [55], in areas which are isolated and difficult to access by vehicle. They were built up during the Ottoman rule, when unfavorable (or even dangerous) socio-historical circumstances imposed existential and security criteria for choosing a residential location rather than economic [48,54]. Due to fear for their own existence, during the Ottoman rule period, many of the Serbian population left the river valleys and basins with fertile soil and retreated to mountainous areas. Because of geomorphological inaccessibility, those areas provided them isolation and relative safety. In the sense of ontology and psychology, this very specific characteristic made these spaces optimal for settlement during historically repressive periods. However, from the perspective of current economic and civilizational needs, the natural conditions which had ensured isolation represent a serious limitation. In addition, they lead to demographic abandonment of space [56]. Such spaces are unacceptable as a location for permanent residence for the vast majority of people (especially youth), and the process of abandoning them is taking place regardless of the economic resources those people have. In these changed circumstances, those settlements have lost the historical meaning for existence, which is why, according to Milošević et al. [54], the lamentation over the sad destiny of Serbian villages is often unjustified and exaggerated, because many of them have become unsustainable from the perspective of the needs of modern civilization.

Spatial enlargement of depopulation, areas demographically extinguished or on the verge of extinction, poses an important dilemma both for the state and local authorities and public opinion in Serbia: what resources do these areas have and are there any objective and sustainable possibilities for their partial demographic and economic revitalization?

During the period of socialism, in an era of emphasized industrialization and urbanization, remote hilly and mountainous villages were marginalized in terms of infrastructure, economy and socio-cultural support. Insufficient attention and financial resources were devoted to their development, and they were mostly seen as a problem rather than as development resource [64]. Nothing has changed so far and at the very beginning of the third decade of the 21st century there is not enough devotion in terms of management and exploiting the resources of abandoned areas in Serbia, neither from state authorities, nor private entrepreneurs. The reasons should be found in the unfavorable demographic and economic conditions in the country, general impoverishment in the transition period, the absence and ineffectiveness of state strategies and plans for the revitalization of rural areas, deficiency of financial resources and lack of interest from investors. The cheap labor market in Serbia is very attractive for direct foreign investors (DFI), and a large part of the national development strategy relies on attracting DFI [71–78]. However, in the spatial sense, the investments of foreign investors are strictly polarized—they are directed towards big cities, traffic corridors, localities with mineral resources and even small depopulated city centers that still have a solid base of an unemployed workforce, but they completely go around rural areas with an unfavorable age structure, a modest amount of workforce and poor traffic connections.

Based on the observation of the contemporary demographic and economic trends in the hilly and mountainous rural areas of Serbia, we stand on the point that in the existing conditions, economic revitalization of abandoned areas is unfeasible, and that even partial demographic revitalization is practically impossible. Revitalization would entail a number of other processes, primarily demographic recovery through return migration and an increase in the birth rate, which would require a larger number of inhabitants in the reproductive period, which is impossible to talk about in the existing negative demographic and economic conditions in Serbia. This is in line with the opinion of Casarejos & Sáez-Pérez [79], who consider that little can be done to revitalize rural areas if they have an unfavorable age and extremely low fertility rates. State investments in the infrastructure and system of public services do not exist, because such activities are not sustainable and profitable without a minimum critical mass, which has long been absent from abandoned areas. In areas without inhabitants or with a very small number of elderly people, there is no economic justification for investing in agriculture, communal and transport infrastructure and the construction of public services. Decades of neglect of villages in the infrastructural, economic and socio-cultural sense deepened the differences between the village and the city and led to the increasingly frequent appearance of “dwarf” settlements, whose demographic extinction is almost impossible to prevent.

According to Milošević et al. [55,56] instead of revitalization, it is more suitable to talk about partial reuse (reutilization) of the resources of abandoned spaces. The number of inhabitants and the age structure in abandoned settlements indicate the fact that the future activation of any resources in these areas must initially exclude all labor-intensive and material-intensive activities, regardless of the existence of natural conditions [48,54,56]. Therefore, alternative models of space utilization are proposed. They include the development of organic farming, animal husbandry, forestry, collection of forest fruits and medicinal plants, rural, weekend and hunting tourism, recreation, nature schools, art colonies and similar low-intensity activities.

The use of abandoned spaces in Serbia is currently completely left to the initiative and enthusiasm of individuals. The main existing form of utilization is reflected in occasional visits by former residents or their descendants, who use their houses as vacation homes, or are engaged in extremely irregular and mostly extensive small-scale agriculture and related activities. In some of the abandoned villages, there are also organized gatherings of larger groups of former residents on some specific dates during the year. However, all these activities are extremely unorganized, spontaneous and of low intensity. In the modern socio-economic circumstances, there are almost no returnees, except in rare cases of the old people returning to their village after retirement. Since almost all of them are over 65 years old, their return does not have positive affect on the demographic and economic revitalization of village.

In the hilly and mountainous rural areas of Serbia, rare entrepreneurial ventures, mainly in the field of rural tourism or agriculture, are linked to the areas with favorable traffic positions, quality roads and with a certain labor force base. There are no similar projects in abandoned areas, due to the lack of manpower and traffic isolation, which cause an increase in transport costs and make any entrepreneurial initiative unprofitable. However, rare examples of “good practice” can be used as models for entrepreneurship development, step by step, as well as for inclusion in the development programs of European Union and other initiatives of the internal community [80]. The inefficiency of the state bureaucracy often hinders and repels potential investment. For example, foreign investors interested in building accommodation facilities for the participants of paragliding competitions in Koritnjak gave up because of the long and complicated procedure for obtaining the necessary permits.

The available resources of the abandoned villages in Serbia could obtain certain functions in the future, whereby tourism is very often recognized as one of the most effective strategies of rural revitalization. Considering “intact nature”, which has usually been found in abandoned rural areas, as well as authentic architecture, the connection between art and

landscape—between urban and rural—could bring authentic value and experience. If the infrastructure capacity in the rural areas is below the national average, those areas could rely on tourism as one of the most effective strategies against depopulation [81]. For example, valorization and utilization of the tourist potential of Stara Planina Mountain (huge hotel complex and a ski center) have caused the initiation of rural tourism as well as renovation of local houses for accommodation purposes in the abandoned areas of the municipality of Knjaževac. All of this was achieved by incentive funds from the Ministry of Agriculture of the Republic of Serbia, favorable loans for tourism development (approved through the National Development Fund), international projects focused on the development of rural areas and support from local self-government and tourist organizations. The majority of the funds were invested in the renovation of neglected houses, training the potential entrepreneurs, renovation of craft workshops, cultural manifestation and other activities [66]. Abandoned villages with a lower degree of isolation are being transformed into weekend settlements. Abandoned areas with a mining tradition can be affirmed in the future on the basis of their industrial heritage (mining shafts, mines, ore processing plants, etc.).

There are also the proposals for transformation of “emptied” areas in Serbia into complexes with various purposes, such as multimedia, art or scientific research centers [82], but such initiatives are far-fetched. Despite their physical collapse, but considering their selling prices, there are a lot of objects which could be adapted for different purposes, with relatively small investments (ethno-villages, cottages, apartments, youth camps, art colonies, hunting lodges, etc.). According to the Census 2011, a total of 112 residential units (mostly houses) were preserved in abandoned villages and they could represent certain bases for development of the aforementioned activities [83]. However, unresolved property relations (the owners have died, or it is difficult to find and reach their inheritors) hamper the possibilities for their utilization.

According to the newest information, hunters are of the most interest in utilization of those objects. Since the number of wild animals in abandoned areas has obviously increased in the wake of population departure, hunting tourism has become one of the rare objective development opportunities. For example, in the village of Papratna, in the municipality of Knjaževac (5 inhabitants in 2011), the village road and approximately 20 houses used by hunters during the hunting season have been renovated [66,84]. In some villages, similar activities have been carried out by the organized cooperation of former residents. For example, in the abandoned village of Tačevac (municipality of Kuršumljija), the displaced population has reconstructed the road, arranged water springs and a village cemetery. They are also constructing a country house with accommodation facilities. For now, this kind of development of hunting tourism has a strictly local character, because the attraction of foreign hunters requires significant infrastructural and organizational investments.

Various programs for the revitalization of rural and abandoned areas are implemented in numerous European countries. The policy of rural development in the European Union is based on the following priorities: (1) encouraging the transfer of knowledge and innovations in agriculture, forestry and rural areas; (2) strengthening the sustainability and competitiveness of all types of agriculture and promoting innovative farming technology; (3) risk management in agriculture; (4) increasing the number of young people and adults who have professional and technical skills for entrepreneurship and employment; (5) restoring, preserving and improving the ecosystem; (6) reducing poverty and promoting the economic development of rural areas [85]. Although the public institution of Serbia and local self-governments declaratively accept these priorities, so far, they have not shown any interest in the resources of abandoned spaces. According to the draft of the Spatial Plan of the Republic of Serbia from 2021 to 2035: “It is necessary to establish a new incentive mechanism for underdeveloped areas”, which we have also identified in the results of our paper. The mentioned areas are also emphasized as protected areas, for example catchment basins (Pčinjski, Raški, Rasinski and Jablanički districts), prominent tourist areas (part of the Pirotski and Zaječarski districts) and protected natural areas (all districts

besides Pomoravski). Some of the priority planning solutions, until 2025, are “restoration of ecosystem’s and production’s function” of abandoned areas, which should be fulfilled by sanctioning the legal obligation of their cultivation or repurposing them for planting forests [86]. It remains to be determined whether there will be enough human and financial capital for the implementation of the aforementioned measures.

In accordance with The Law on Ministries in October 2020, the Ministry of Rural Care was established for the first time in the history of Serbia. The objectives of the Ministry’s work are: “strategic assessment of the position of villages and rural population; proposing measures and activities to improve living and working conditions in the countryside; nurturing traditions and the traditional way of life in the countryside, in order to preserve the cultural and historical contents of rural areas, as well as other tasks determined by law” [87].

As one of the few activities undertaken by the state authorities with the aim to revitalize the rural area is the financing program for encouraging the purchase of real estate for young people who are ready to leave the city and settle in the countryside, and it has been functioning since June 2021. The goals of the program are “increasing the number of inhabitants in villages, reducing the average age of the population in villages, increasing the birth rate and starting the economy”. The maximum amount per object (house with associated objects) allocated by the state is 1.2 million Serbian dinars (about 10,200 euros) [87]. Some of the most important applying conditions are that the candidates need to be the citizens of the Republic of Serbia, are less than 45 years old, do not own any real estate and are married or live in cohabitation. Some of the additional conditions are: to live independently, or in society with the extended family members, in the countryside in leased estate; to have formal education related with agriculture, veterinary science, medicine or craftwork; to live in urban areas, independently or in society with extended family members, in a leased apartment and have a willingness to move to the countryside. During the first ten years of the program, young married couples are prohibited from selling the property they buy or to mortgage it [87]. Despite this, the majority of young married couples decide to live in big cities, which offer a semblance of financial and social security for their descendants. The first results of this project, which continued in 2022, indicate that there is a real interest for it, but mostly for buying houses and moving to rural areas close to cities, with relatively favorable infrastructure, traffic connections and public services, while on the other side, abandoned areas are still being avoided.

The presented study, like any quantitative research, has its limitations. The use of formal databases such as statistical ones is subject to errors arising from agricultural and population censuses. The methodology used in this paper cannot fully depict the abandoned territory because it is directly related to the time when the population data were collected. With the assumption that the population will be less and less over time, research after the new census in 2022 should indicate the expansion of the abandoned space. The satellite images used to study land use do not provide the most precise data on, e.g., the type and value of the vegetation that grew on the site of the former arable land. For better data quality, it is necessary to confirm the satellite database in situ.

## 6. Conclusions

The aim of this work was to determine, based on the proposed parameters, the area and geographical distribution of the abandoned space in Serbia. The presented methodology can contribute to the design of a classification framework for rural areas that share similar characteristics. The results of our research indicate the spatial enlargement of abandoned areas and gradual merging of depopulated regions with traditional emigration regions, as well as with regions with severe development problems. In addition to the already mentioned demographic and economic problems, hardly accessible villages are endangered by wildfires, spates, erosion, winds, blizzards, and also by the uncontrolled increase of wild animals.



The discussion gave a general overview of the current situation and a critical review of the development possibilities of the abandoned areas of Serbia. Nowadays, the opportunities for the economic and demographic (re)activation of abandoned villages in Serbia are extremely modest, state development strategies and legal procedures are very ineffective, and interest in private investment is very low. The situation is particularly unfavorable in the villages of the “Security zone” where, in addition to other negative factors, revitalization is not possible due to unfavorable geopolitical circumstances, which initially repels all actors interested in investing. Therefore, compared to the other regions in Serbia with no such security and geopolitical risks, abandoned areas along the administrative line with Kosovo and Metohija are in the worst position. As “weak points” of state administration, these abandoned areas represent a unique challenge at every level of governance [88]. There is almost zero initiative regarding (re)activating any economic potential in the so called “Security zone”. That is why all the modest measures taken by the state in order to revitalize its own rural areas have completely bypassed this zone. The results of this research should not be considered as axioms, but as starting assumptions for creating new hypotheses related to the research of abandoned areas in Serbia. They also could contribute to further studies on this contemporary, but insufficiency studied, global phenomenon. Among the tasks of further research in abandoned areas in Serbia, the following stand out: typology of ownership of abandoned parcels, morphometric characteristics of abandoned cadastral municipalities, determining the area and quality of abandoned agricultural land, economic values of forest funds, economic value of renewable energy sources, threats to the environment, condition of abandoned objects (mostly houses) and the possibilities of their (re)use, etc.

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