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## **AGRARIAN POTENTIAL IN THE FUNCTION OF ECONOMIC DEVELOPMENT OF THE MUNICIPALITY OF VARVARIN**

Nemanja Josifov<sup>1</sup>, Marko Sedlak<sup>1</sup>, Milan Mladenović<sup>1</sup>

**Abstract:** The paper analyzed the agrarian potential at the level of settlements in the municipality of Varvarin. This work aims to identify the most significant factors that affect agrarian potential. The following methods were applied: the method of successive dividers for determining the direction of agricultural land use, the weighting method for obtaining a reference value for calculating the agricultural potential, and the correlation coefficient for the analysis of cause-and-effect relationships between the value of the agricultural potential by settlements and used parameters. The paper provides an overview of the key problems in agriculture at the local, regional, national, continental, and global levels, including programs implemented by certain developed countries to revitalize agriculture.

**Keywords:** land use change; deagrarianization; depopulation; perspectives of agriculture.

### **Introduction**

Agriculture plays an important role in the overall economy at the level of the state and individual settlements. It represents the basis of the population's life because it ensures its food security. However, there are many examples of irrational agricultural land use, to obtain the highest possible yields in a short period. Intensification of agriculture can lead to the degradation of arable land due to the tendency to obtain higher yields and to an increased area under cultivation due to higher profitability (Villoria et al., 2014). Numerous pieces of evidence indicate that agricultural land abandonment is widespread worldwide, driven by several factors, and has strong implications for biodiversity, ecosystems, and living standards (Prishchepov, Schierhorn & Flöw, 2021). Abandonment of agricultural land has negative effects (possibility of fire spread, increasing population emigration) and

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<sup>1</sup> University of Belgrade – Faculty of Geography, Studentski trg III/3, Belgrade;  
e-mail: necajosifov98@gmail.com (corresponding author)

positive effects (reduction of erosion, forest expansion, regulation of heat and moisture, preservation of habitats, stabilization of the hydrological cycle) on the environment (Pazúr et al., 2014).

Agriculture is directly related to the location of the area. There is a difference between rural areas that are part of an urban zone, rural areas that are well connected to urban centers and are part of the urban network, and remote rural areas that are weakly connected to any type of urban entity (Viñas, 2019). The rural area of the central part of Serbia was divided on rural centers on the axes of Serbia's development (such as Corridor X) and sparsely populated and underdeveloped villages in mountainous, peripheral, and border areas (Martinović & Ratkaj, 2015).

The relationship between agricultural production and the environment is complex and multifaceted (Baaken, 2022). Agriculture affects soil structure and fertility, geochemical and hydrological cycles, soil salinization, and pollution of underground and surface water (Милинчић, Туцовић & Мандић, 2013). Agricultural activity is affected by numerous physical-geographical factors, phenomena, and processes: soil erosion (Abdelsamie et al., 2023; Bogunovic, Telak & Pereira, 2020; Krstić & Paunović, 2022), climate changes (Michler et al., 2019), soil quality (Zhichkin, Nosov & Zhichkina, 2021) and soil degradation (Kertész, Nagy & Balázs, 2019).

Demographic and socioeconomic factors are considered the most significant factors in the abandonment of agricultural land (Negese, 2021). Human resources are considered one of the key factors of agricultural production (Раткај & Сибиновић, 2012). The process of deagrarization in the rural areas of Serbia is connected with the processes of depopulation and senilization of the rural population (Manojlović et al., 2022). The depopulation process is partially the result of emigration and is accompanied by a significant aging of the population (Pérez, Pásztor & Tátrai, 2015; Horvat & Žiberna, 2020), which makes it even worse the possibility for the revitalization of agricultural activity. Agriculture plays an important role in rural development because it provides and manages the life of the rural population (Rajczi, Vörös & Dajnoki, 2017). In the last three decades, Serbia has lost about 1/3 of its agricultural land, most of which is arable land (Dašić & Labović, 2020).

The processes of industrialization in the post-war period, migration between the countryside and the city, and urbanization in conditions of inadequate traffic connections between urban and rural areas intensify deagrarization and deruralization (Bubalo-Živković et al., 2018; Mićković et al., 2020). The problem of rural abandonment and deagrarization in the villages of Eastern and Southern Europe is the result of post-industrial changes (Vaishar et al., 2021). The process of transformation of agricultural areas is the result of the relationship between urban and rural lifestyles and the effect of globalization has a further influence (Sibinović, 2012). The process of urbanization affects the transformation of agricultural areas and forests into urban zones near cities

(Bogunović et al., 2020). Some authors dealt with the conflict between the development of tourism and changes in agricultural land (Ghadami et al., 2022).

Politics played a major role in changes in land use and abandoned in countries that had a socialist system until the 1990s (Živanović et al., 2022), such as Poland (Gruchelski & Niemczyk, 2020) and Czech (Zagata, Hrabák & Lošťák, 2020). The post-socialist transformation of the land led to the fragmentation of large agricultural areas, which resulted in the fragmentation of plots and the increase of uncultivable land (Manojlović et al., 2021). The economic recession and reduced agricultural production in Serbia at the end of the last century were the results of foreign political factors, such as the disintegration of the SFR Yugoslavia, economic sanctions, and NATO aggression, but also internal factors such as the democratic revolution in 2000 (Sibinović, 2015).

Based on the mentioned factors that affect agriculture, three starting hypotheses are distinguished in the paper: 1) Agricultural activity in the territory of Varvarin municipality is concentrated mainly in the lower hypsometric zones and in the river valleys; 2) Agriculture is dominant in the territory of Varvarin because most of the settlements are concentrated in the valleys; 3) Agrarian potential is most closely related to population aging.

The analysis of the agricultural potential of Varvarin municipality has multiple scientific and practical significance: indicating the natural potentials that the mentioned municipality has for the development of agricultural activities in accordance with the concept of sustainable development; emphasizing the demographic problems that led to the demise of agriculture; identifying the key processes that cause the marginalization of agricultural activity, which causes the economic recession of the municipality; indicating the importance of inter-municipal cooperation for the development of agriculture and the revitalization of rural areas; systematization of positive practices and programs that are implemented in more developed countries of the world, with the aim of considering the possibility of implementing them in the case study of the municipality of Varvarin; overview of advantages, disadvantages, potentials and threats for the development of agriculture in the municipality of Varvarin based on natural resources, demographic potential and economic situation.

### **Study area and research methodology**

The municipality of Varvarin (246.47 km<sup>2</sup>) is located in the Rasina region, in the central part of the Republic of Serbia. The location at a distance of 10 kilometers from Corridor X and good traffic connections with Paraćin, Kruševac, and Jagodina

indicate a favorable traffic-geographical and economic-geographical position. The geological structure of Varvarin municipality is dominated by Neogene sediments since fertile soil suitable for agricultural activities is formed on them. The following soil types are represented on the territory of Varvarin: fluvisol, eutric cambisol, rankers, vertisol, and regosol. The mentioned area geotectonically belongs to the Serbian-Macedonian massif (Pavlović et al., 2017). According to Keppen, Varvarin has a moderately warm and humid climate (Cfb) (Milovanović, Stanojević & Radovanović, 2022), in a zone with an average annual temperature of 11-12°C (Bačević et al., 2021) and 590-670 mm of precipitation (Radaković et al., 2018). According to the flood risk map (Новковић, Драгићевић и Ђуровић, 2022), Varvarin municipality is located in the medium flood risk zone, with 226 registered flash floods in the immediate catchment of Velika Morava (Петровић, 2021), which is an important factor for agriculture. During the disintegration of Yugoslavia, wars, great crises, sanctions, and NATO aggression, Varvarin municipality became an emigration zone. Varvarin has recorded a continuous decline in the number of inhabitants since the 1953 census, but it has intensified since the end of the last century (Varvarin municipality had 23,821 inhabitants in 1991 and 17,966 inhabitants in 2011). Depopulation, population aging, and economic backwardness are the key processes that affect agriculture and the development of the municipality of Varvarin.

The micro-location of the settlement has a great influence on the possibilities of engaging in agricultural activities. The largest number of settlements in the municipality of Varvarin are concentrated on the banks and valley sides of the largest rivers of the municipality because the most productive soil (fluvisols) is found in that area. Settlements at higher altitudes are predominantly oriented toward fruit growing, viticulture, and pig farming, due to the lower fertility of the soil. Based on the differences in natural conditions, it is possible to distinguish the following types of micro-locations of settlements in the municipality of Varvarin:

- in the foothill of Juhor (Bačina, Gornji Krčin, Izbenica, Suvaja and Orašje),
- On the slopes of Blagotin (Bačina, Karanovac, Mala Kruševica and Orašje),
- On the banks of the rivers (Zalogovac river - Zalogovac, Parcane potok - Parcane, periodic flow of Suvaja - Suvaja, Cernica potok - Cernica),
- On the left bank of the rivers (Velika Morava - Varvarin selo, Varvarin and Gornji Katun, Kalenić river - Donji Krčin, Pajkovac, Varvarin),
- On the right bank of the rivers (Velika Morava - Donji Katun, Kalenić river - Varvarin selo, and Karanovac),
- On the valley floor of Zapadna Morava (Bošnjane),
- On the valley sides of the rivers (Kalenić river - Bačina and Toljovac, Bošnjane river - Bošnjane, Marenovo potok - Marenovo, periodic Izbenica stream - Izbenica),

*Agrarian potential in the function of economic development of the municipality of Varvarin*

- On the left valley side of the rivers (Kalenić river - Gornji Krčin, Kruševica potok - Mala Kruševica, Zapadna Morava - Maskare),
- Between Velika Morava and Juhor (Obrež) (Стаменковић, 2001).



*Map 1. Network of settlements of Varvarin municipality*

In the paper, during the data analysis, the method of successive divisors was applied, which represents a mathematical model for the matrix calculation of the ratio of the values of the variables, in this case, the basic groups of plant production. The reference values of the variables are grouped in 6 rows, in which each row indicates the result of dividing the variable with a common denominator (from 1 to 6). The highest 6 scores in the matrix determine the representation of plant crops in the structure of production.

The comparative method was used to compare rural settlements based on numerical values of absolute and relative indicators. A comparative analysis of this type is possible only if conditional units are established (reduced area, conditional head, grain unit) whose diversity is reduced to comparable values by the method of weighting. The use of the comparative method in this study implied an interweaving with the geographical method - the spatial aspect (Сибиновић, 2014).

Demographic and economic indicators that affect the agricultural potential of Varvarin municipality are discussed in the paper. Among the selected indicators, using the Pearson's correlation coefficient ( $r$ ), the mutual connection between the agrarian potential by settlements and the most significant factors influencing it was differentiated, based on the degree of correlation. The calculation of the correlation coefficient ( $r$ ), based on the data which were processed by years, is performed using the formula (Bluman, 2009):

$$r = \frac{n\sum XY - (\sum X) * (\sum Y)}{\sqrt{[n\sum X^2 - (\sum X)^2] * [n\sum Y^2 - (\sum Y)^2]}}$$

The correlation was also calculated between individual parameters (number of inhabitants and average age, number of inhabitants and number of the agricultural population, etc.) to consider in more detail the causal relationship between the factors that have influence on the mentioned processes. The following parameters were considered:

- Number of inhabitants ( $B_s$ )
- Population density ( $G_n$ )
- Number of households ( $B_d$ )
- Average number of members per household ( $B_{dp}$ )
- Average age of the population ( $S$ )
- Number of the agricultural population ( $S_{polj}$ )
- Population Change Index ( $I_{bs}$ )
- Index of change in household number ( $I_{bd}$ )
- Population Aging Index ( $I_{ss}$ )
- General agricultural population density ( $AGN$ )
- General reduced agricultural population density ( $AGN_r$ )
- Actual specific agricultural population density ( $AGN_{ss}$ )
- Actual reduced agricultural population density ( $AGN_{sr}$ )
- Agricultural land ( $P_p$ )

Agrarian potential is used in geographical surveys of agricultural activity to determine the degree of use of agricultural space. It is calculated according to the following formula (Раткај & Сибиновић, 2012):

$$Ap = \left( \frac{\check{z}_{in}}{U_{zio}} + \frac{U_{gn}}{U_{go}} \right) \div 2 \times 100$$

Which  $A_p$  represents agricultural potential;  $Z_{in}$  – the number of grain units in the settlement;  $U_{žio}$  – the sum of grain units of all settlements of the studied territory;  $U_{gn}$  – conditional heads in the settlement;  $U_{go}$  - the sum of conditional heads of all settlements in the research territory.<sup>2</sup>

### **Research results**

The largest expanse of agricultural land in the municipality of Varvarin is occupied by arable land and gardens (8,851.75 ha), followed by orchards (503.56 ha) and vineyards (354 ha). Meadows occupy 340 ha surfaces and pastures are significantly less. The smallest area covers fishponds, puddles, and reeds. The topography of the terrain favors the development of arable land and gardens. Fruits are mainly grown in the hilly areas on the slopes of Juhor, which is the highest mountain of the Varvarin and the Blagotin slopes. Meadows and pastures are located in the higher terrain of Temnić, and the largest areas belong to the settlements of Karanovac, Bošnjane, and Bačina. Apart from limitations in agricultural production, an additional problem in livestock breeding is the small share of meadows and pastures in the total area of the territory of the municipality of Varvarin.

In the category of vegetables, melons, and strawberries, on a total area of 546 ha in 2012, the largest crops were pepper (188 ha), strawberries (184 ha), and fruit trees (93 ha). In 2012, plantings of other crops occupied a significantly smaller area. The total area under fodder crops was 1,072 ha, which represents the largest agricultural area after grain. Of the mentioned 1,072 ha, the largest area was occupied by alfalfa (513 ha) and clover (424 ha). In 2012, 504 ha of Varvarin municipality were under fruit species. Therefrom, the largest part was planted with plums (249 ha), blackberries (79 ha), and apples (47 ha). Other fruit species occupied a significantly smaller area of land. About 10% of the used agricultural land was under irrigation systems (План развоја општине Варварин 2021 – 2028).

The method of successive dividers was used to analyze land use trends in the territory of Varvarin municipality. It is suitable for determining the agricultural orientation of settlements based on agricultural areas under arable land, orchards, vineyards, meadows, and pastures. The settlements of Varvarin municipality have an

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<sup>2</sup> Cereal units (wheat units) are determined on the basis of protein and starch content. The coefficient for wheat is 1 (1= 100 kg of wheat), while the coefficients for other plant production and livestock products are determined based on it. The number of grain units per 100 ha of arable land is usually used as an indicator. A large livestock unit (conditional head) is used in livestock breeding. It is a cattle (beef) of 500 kg weight, which has a coefficient of 1. Coefficients for other types of livestock are calculated based on it. The number of conditional heads per 100 ha of agricultural land is usually used as an indicator (Степић и Јаћимовић, 2006).



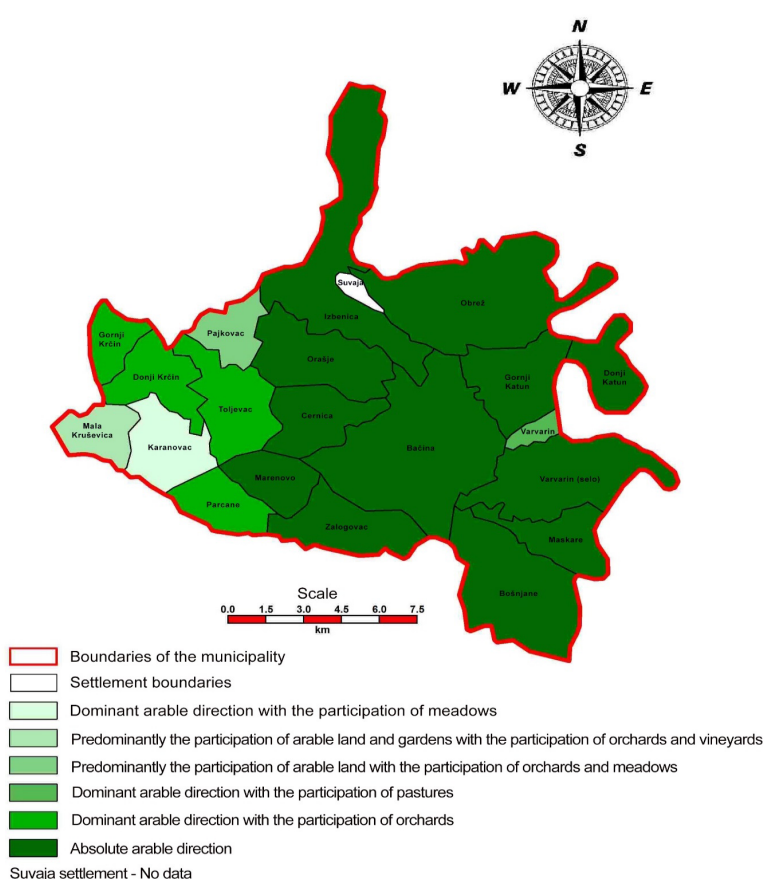
absolute, dominant, and a smaller number of them predominantly arable directions. As many as 12 settlements have the code  $O_6$ , which shows that the absolute arable direction is represented, and this is a consequence of the location of these settlements in the valleys of the large rivers of Temnić (Velika Morava, Zapadna Morava, and Kalenić river). Typical representatives are Obrež, Bačina, and Bošnjane. Other settlements with  $O_6$  land use direction are Varvarin (selo), Gornji Katun, Donji Katun, Zalogovac, Izbenica, Marenovo, Maskare, Orašje, and Cernica. Settlements located on the hilly terrain of Varvarin municipality have slightly less arable land, and there are also orchards. These are the settlements that have a dominant arable direction with the participation of orchards ( $O_5 V_0$ ) and these are Gornji Krčin, Donji Krčin, Parcane, and Toljevac. The dominant arable direction with the participation of meadows ( $O_5 L_1$ ) had Karanovac, while the dominant arable direction with the participation of pastures ( $O_5 P_1$ ) had Varvarin (varoš). The most heterogeneous settlements are Mala Kruševica, in which orchards and vineyards participate and which belongs to the direction of predominantly arable land and gardens with the participation of orchards and vineyards ( $O_4 V_0 V_1$ ), and Pajkovac, where orchards and meadows are equally represented.

The analysis of agricultural potential determined the most productive settlements in agricultural production in the territory of the municipality of Varvarin. This indicator refers to the possibility of agricultural development, based on two parameters: grain units and conditional heads. Obrež (15.22%), Bošnjane (13.69%), and Bačina (12.78%) have the greatest agricultural potential because they have the number of grain units and conditional heads, i.e. head of livestock, which is significantly above the municipal average, which improves agricultural production. These three settlements are traditionally agricultural due to the small dissection of the relief and the fertile soil on which quality yields are achieved. In Obrež, which is positioned between Juhor and Velika Morava (Стаменковић, 2001), the largest areas are planted with cereals (corn - 623.48 ha and wheat - 611.84 ha) and fodder plants (alfalfa - 51.97 ha). The highest yield is achieved by cereals (corn – 2,560.13 t and wheat – 1,088.90 t), and potatoes (918.77 t) from vegetables. According to the number of probationers, Obrež is in third place among the settlements of the Varvarin municipality, behind Bošnjane and Bačina. In Bošnjane, which is located on the valley floor of the Zapadna Morava and the valley sides of the Bošnjane river (Стаменковић, 2001), the largest areas, as in Obrež, are under cereals (corn - 286.47 ha and wheat - 247.39 ha) and forage plants (alfalfa - 39.27 ha), while they achieve the highest yield (corn – 1,176.30 t, potatoes – 1,133.21 t and wheat - 440.28 t), and these crops also have the most grain units, as in Obrež. Of all the settlements in the Varvarin municipality, Bošnjane has the largest number of livestock, (poultry - 203,411), which is evidenced by numerous poultry farms and, therefore, the highest number of conditional livestock. Poultry is less demanding than cattle, sheep, pigs,



and goats, so it is more numerous. Chicken meat is in great demand on the market, it has a good price, which has a positive effect on the population of the Temnić region to engage in poultry farming. In Bačina, which is located on the valley sides of the Kalenić river and the slopes of Blagotin (Стаменковић, 2001), the largest areas are where corn (366.6 ha), wheat (332.1 ha) and grapes (56.88 ha) are grown. The mentioned crops achieve the highest yield (corn – 1,505.33 t, wheat - 591.04 t, and grapes - 553.05 t) and have the most grain units. Cereals are grown in Bačina at the bottom of the Gornjovelikomoravska basin, in the valley of the Kalenić river, while the areas under grapes are mostly located on the slopes of the Blagotin hill. Bačina is in second place after Bošnjane in terms of the number of conditional heads of livestock, poultry farming (5,604 heads) and pig breeding (4,060 heads) dominate.

### Ways of using agricultural land in the municipality of Varvarin



Map 2. Ways of using agricultural land in the municipality of Varvarin

On the other hand, the settlements of the mountainous terrain of Gornji Temnić (western part of Varvarin municipality) such as Pajkovac (0.77%), Donji Krčin (1.25%), and Gornji Krčin (1.55%) have the lowest agricultural potential due to greater fragmentation relief and harsher climatic conditions that affect the limited yield of crops, especially cereals, so the population mainly resorts to fruit growing (plums, apples, apricots), viticulture and cattle breeding. Therefore, it is observed that the settlements of the Varvarin municipality, which are located at the bottom and the rim of the Velika Morava basin, have the greatest agricultural potential. It should be emphasized that arable land covers an area of 10,384.11 hectares or 42% of the area of the municipality. Obrež, Bačina, Bošnjane, and Varvarin (selo) have the largest areas of arable land. Primacy is held by Obrež with 1,668.14 ha of arable land. The distribution of arable land is determined by the geological base, which is mainly composed of Neogene sediments. The most fertile soil is in the alluvial plain of Velika Morava, which used to often overflow and deposit silt.

In contrast to them, the settlements of Gornji Temnić have much less arable land due to their specific hilly and low-mountainous micro-location with a greater slope of the terrain, which favors the intensification of erosive processes. The geological base here is old crystalline slates and gneisses, and there are shallow skeletal soils of limited fertility. Pajkovac has only 89.15 ha, and Donji Krčin, which is the center of Gornji Temnić in the Krčin basin and the Kalenić river valley, has 188.48 ha of arable land.

In table no. 2 shows the relationship between agricultural potential and demographic and economic indicators at the level of settlements in the municipality of Varvarin. The values of agricultural potential in the settlements of Varvarin municipality are positively correlated with most of the analyzed parameters. Exceptions are the parameters of the average age of the population, population aging index, and population density. The aging of the population hurts the possibility of engaging in agricultural activities, as indicated by the low negative correlation between the agricultural potential of the municipality of Varvarin with the average age of the population by settlement ( $r = -0.31$ ) and the index of change in the average age of the population ( $r = -0.29$ ). No correlation was established between agricultural potential and population density, as its value is  $r = -0.03$ . The population density in the territory of Varvarin municipality is positively correlated with the agricultural population ( $r = 0.59$ ), the number of households ( $r = 0.54$ ), the number of the population ( $r = 0.44$ ), the index of population change ( $r = 0.41$ ) and the index of change in the number of households ( $r = 0.4$ ).

*Table no. 1: Agrarian potential of settlements in the municipality of Varvarin*

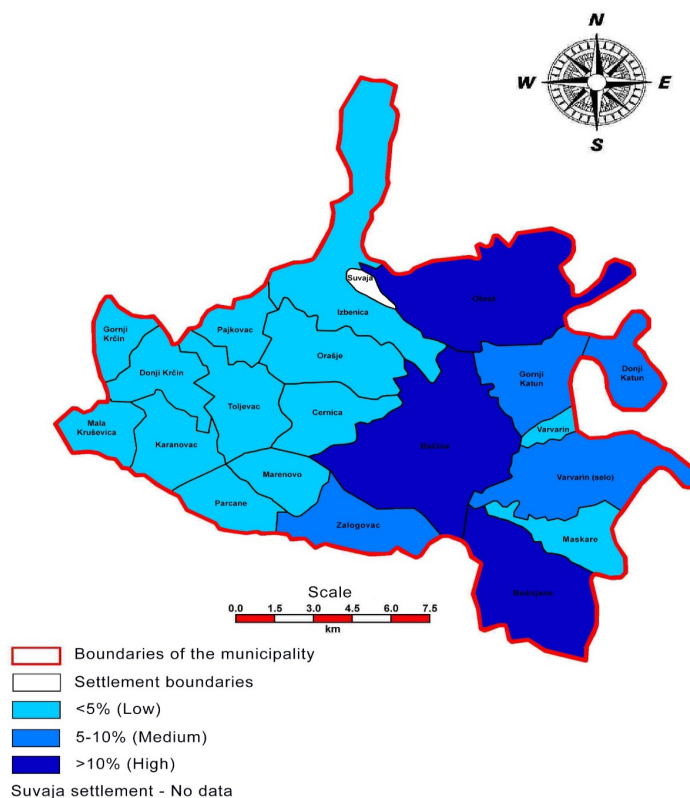
Settlement name	Grain units	Conditional heads	Agrarian potential (%)
Obrež	42,529.45	1,436.88	15.22
Bošnjane	21,694.37	2,189.61	13.69
Baćina	25,218.99	1,774.02	12.78
Varvarin (selo)	19,253.29	1,369.78	9.82
Donji Katun	15,428.27	731.73	6.38
Gornji Katun	15,142.27	719.92	6.27
Zalogovac	13,818.59	556.68	5.31
Parcane	10,761.97	366.12	3.86
Orašje	7,729.99	484.67	3.68
Marenovo	8,162.49	428.42	3.54
Maskare	6,908.89	362.93	3
Varvarin (varoš)	7,052.7	275.86	2.68
Mala Kruševica	7,424.36	225.43	2.55
Karanovac	5,956.86	208.02	2.16
Izbenica	4,035.99	299.83	2.11
Toljevac	4,552.46	215.57	1.88
Gornji Krčin	3,124.64	211.63	1.55
Cernica	2,981.31	207.39	1.5
Donji Krčin	2,832.44	154.8	1.25
Pajkovac	1,998.51	82.01	0.77
Suvaja			
Municipality of Varvarin	226,608	12,301.25	100

*Source: Agricultural census, 2015*

The agrarian potential is highly dependent on the number of inhabitants per settlement and the number of the agricultural population. A very high correlation was established between the agricultural potential of the Varvarin municipality settlements and the agricultural population per settlement ( $r = 0.92$ ). The largest settlements in the municipality of Varvarin with the largest population also have the most inhabitants engaged in agriculture: Obrež (525 agricultural inhabitants), Baćina (388 agricultural inhabitants), and Bošnjane (335 agricultural inhabitants). The number of agricultural population has a high correlation with the number of population per settlement ( $r = 0.76$ ) and the number of households per settlement ( $r = 0.7$ ), a medium-high correlation with the average number of households ( $r = 0.49$ )

and a low correlation with the index of the change in the number of inhabitants ( $r = 0.29$ ) and the index of the change in the number of households ( $r = 0.31$ ).

### **Agrarian potential of settlements in the municipality of Varvarin**



*Map 3. Agrarian potential of settlements in the municipality of Varvarin*

The same rank of correlation (very high correlation) was established between the agricultural potential and the number of inhabitants per settlement ( $r = 0.85$ ). Settlements with a larger number of inhabitants have a very high correlation with agricultural areas ( $r = 0.95$ ) and a high correlation with the agricultural population ( $r = 0.76$ ). The number of inhabitants of the settlements of Varvarin municipality has a negative correlation with the average age of the population by settlement ( $r = -0.49$ ) and the population aging index ( $r = -0.44$ ), which further complicates the possibility for agricultural development.

A high correlation was also established between the agricultural potential in the settlements of Varvarin municipality and the number of households ( $r = 0.79$ ).

The larger number of households is directly related to the number of inhabitants ( $r = 0.99$ ) and the agricultural area per settlement ( $r = 0.97$ ). Obrež with 3,062 inhabitants has over 2,000 ha of agricultural land, as does Varvarin (2,169 inhabitants) with over 2,208 ha of agricultural land. The number of households has a negative correlation with the average age of residents per settlement ( $r = -0.49$ ) and the population aging index ( $r = -0.44$ ), because the elderly population mostly remains living alone. In most settlements of Varvarin municipality, a drastic decrease in the number of households was observed between 1991 and 2011, from 6,328 households in 1991 to 5,544 households in 2011. Their number increased in Bošnjak (from 520 to 530) and Varvarin (from 739 to 780). This increase is due to the division of larger families into smaller ones. Also, a small percentage of the population moves to Varvarin, which is the municipal center and functionally the most significant settlement of the entire municipality, especially from the settlements that gravitate to it, which contributes to the increase in the number of households. In contrast, Suvaja (from 110 to 42 households) and Cernica (from 109 to 64 households) had the largest decrease in the number of households between 1991 and 2011. These changes are a consequence of the closing down of nursing homes. In Suvaja, emigration trends were most intense in the last two decades of the 20th century and the first decade of the 21st century. The population mostly emigrated to Germany and Austria. In 1981, 1,033 inhabitants lived in the mentioned settlement. The share of young people was high. After the economic crisis, sanctions, and NATO aggression, in the period between 1991 and 2002, this settlement at the foot of Juhor was left without 346 inhabitants due to negative natural growth and migration. According to the census data from 2011, it had 105 inhabitants, which makes it the smallest settlement in the territory of the municipality of Varvarin.

A high correlation ( $r = 0.74$ ) was established between agricultural areas and the agricultural potential of settlements in the municipality of Varvarin. The agricultural areas of the municipality of Varvarin have a very high correlation with the number of households and the number of inhabitants ( $r > 94$ ), a medium-high correlation with the population density, the index of the change in the number of inhabitants, and the index of the change in the number of households ( $r = 58-59$ ). Agricultural areas are negatively correlated with the average age of the population and the population aging index ( $r < -40$ ).

A high correlation was established between agrarian population density and agrarian potential ( $r = 0.63$ ). A medium correlation was established between the agricultural potential and the index of change in the number of households, which has the highest correlation with the index of change in the number of inhabitants ( $r = 0.96$ ), while it has a medium-high correlation with the number of households ( $r = 0.53$ ) and the number of inhabitants ( $r = 0.52$ ). Agrarian potential achieves a moderate correlation with the index of population change ( $r = 0.42$ ). The mentioned

parameter has a borderline value between low and medium-high correlation with the actual specific agrarian population density ( $r = 0.40$ ), low correlation with the actual reduced agrarian population density ( $r = 0.37$ ), and very low correlation with the general reduced agrarian population density ( $r = 0.14$ ).

The average age of the population of Varvarin municipality is increasing, which may pose a threat to the development of agriculture in the future. The settlements of Gornji Temnić have the highest average age: Karanovac (52.7 years), Mala Kruševica (49.7 years), and Donji Krčin (49.4 years). The most depopulated are the settlements in the western part of the municipality of Varvarin, the number of economically inactive populations (dependent population) is increasing, which adversely affects the economy of the municipality of Varvarin.

Table no. 2: Correlation between agricultural potential, demographic and economic indicators of the municipality of Varvarin

	$B_s$	$G_n$	$B_d$	$B_{dp}$	$S$	$S_{polj}$	$I_{bs}$
$Ap(r)$	0,8457	-0,03	0,79	0,4122	-0,31	0,92215	0,41935
	$I_{hd}$	$I_{ss}$	$AGN$	$AGN_r$	$AGN_{ss}$	$AGN_{sr}$	$P_n$
$Ap(r)$	0,44356	-0,29276	0,63378	0,13739	0,4065	0,36876	0,74054

Source: Statistical Office of Serbia

An important segment of agricultural development in the territory of Varvarin municipality is the level of mechanization applied in this activity. According to the agricultural census from 2012, in the territory of Varvarin municipality, agricultural households owned a total of 4,971 tractors, of which 4,940 tractors are older than 10 years. This means that the average farm owned less than two tractors (План развоја општине Варварин 2021 – 2028).

## Discussion

Low-paid work in agriculture, unavailability of non-agricultural products and services, and high unemployment are the key problems of deagrarianization and abandonment of rural areas (Wojewódzka-Wiewiórska, 2019). In many countries of the European Union, there is a tendency to reduce the share of expenditures for agricultural activities at the state level (Bachev, 2019). Eurostat conducted a farm structure survey and found that 55.8% of European farmers are over 55 years old, 31.4% are over 65 years old, and only 6% are under 35 years old. This points to the challenge of future rural development, i.e. the “problem of young farmers”, which implies low population renewal rates in the agricultural sector in the European Union (Plana-Farran & Gallizo, 2021). Production potential is manifested in the country’s resources and labor force, but its rational use is hindered by structural deficits,



such as the fragmentation of the agrarian structure and poor soil quality (Pawlak, Smutka & Kotyza, 2021). The number of employees in agriculture is decreasing in Serbia (Stojanović, 2022). Mechanization and modernization of agriculture have led to less need for labor in that activity (Babović, Lović-Obradović & Prigunova, 2016). By applying modern technology in agriculture, yields increase significantly, but this leads to a drop in the price of agricultural goods on the market (Паткај & Сибиновић, 2012). One of the reasons for abandoning agricultural activity in Serbia is the low selling price of agricultural products (Dašić & Labović, 2020).

In the context of the prospective development of agriculture, as a potential solution to the economic, social, and ecological challenges of the 21st century, the “Precision Agriculture” program is being imposed, which would apply the most modern technology (Yarashynskaya & Prus, 2022). Guth M. et al. (2020) analyzed the economic viability of farms under the common agricultural policy of the European Union member states. In developed countries, the idea is to first solve demographic problems through population policy measures (encouraging the birth rate) and then to activate those areas economically (Wegren, 2016). The measures applied to prevent depopulation in rural areas are related to agriculture and mostly refer to support for farmers (Tianming, Ivolve & Erokhin, 2018). Among the priorities of rural development in the European Union, some concern agriculture, namely: encouraging the spread of knowledge and innovation in agriculture, forestry, and rural areas; strengthening the sustainability and competitiveness of all types of agriculture, promoting innovative farming technology and sustainable forest management; risk management in agriculture; restoration, preservation and improvement of ecosystems in connection with agriculture and forestry (Diaz-Sarachaga, 2020). The project “Smart and competitive rural areas” among the key issues for the progress of rural areas emphasizes the importance of the modernization of agricultural business, which would enable the development of new products and the penetration of new markets (Battino & Lampreu, 2019). The funds of the European Agricultural Fund for Rural Development encourage rural entrepreneurship, especially for young entrepreneurs in the early stages of business, as part of the measures of regional and national rural development programs (López, Cazorla & Panta, 2019). Some European countries focus on organic agriculture (Zagata, Hrabák & Lošťák, 2020).

According to land, climate, and water resources, Serbia has the potential for agricultural development, but it is not fully utilized (Ljubojević, Blanuša & Petrović, 2022). During the transition period, around 27,500 jobs in agriculture in Serbia were abolished. This is a problem not only for agriculture and agricultural management policy but also for the entire concept and strategy of development after the post-transition period (Milanović, Stevanović & Dimitrijević, 2016). Abandonment of settlements and abandonment of arable land in Serbia is most pronounced south of 43° 53' N i.e. south of the parallel that crosses Užice, Čačak and Paraćin (Joksimović



& Golić, 2021). According to World Bank data, the share of agriculture in Serbia's GDP was 17.8% in 2001, 8.5% in 2010, and 6.3% in 2020 (Ljubojević, Blanuša & Petrović, 2022). On the territory of Varvarin municipality, a process of population concentration and agricultural activity was established at lower altitudes and in river valleys. This process is in agreement with the Jablanica River Basin, where in the zone up to 500 m the share of arable land is 68.2% (Gocić, 2020), while in the Nišava River Basin in the same zone, it is 55.4% (Manojlović et al., 2017).

The most promising agricultural potential of Varvarin municipality is a fertile land. This fact is the basis for the development of intensive agriculture, which can positively affect the economy of the municipality of Varvarin. It is also important to take care of the preservation of agricultural land, that is, to implement measures to protect the pedological cover. Agriculture must be complementary to other sectors of activity. In this sense, it is necessary to invest in the construction of additional plants for the processing of agricultural products, to obtain finished products and increase the competitiveness of the municipality of Varvarin on the domestic and foreign markets. The economic orientation of the largest settlements of the municipality of Varvarin located at the bottom and rim of the Gornjovelikomoravski basin (Obrež, Bošnjane, Maskare, Varvarin selo, Gornji Katun, Donji Katun, Cernica, Suvaja, Izbenica, Orašje, and Bačina) is oriented towards farming, vegetable growing, growing roses and seedlings material.

The settlements in Gornji Temnić (Donji Krčin and Gornji Krčin, Pajkovac, Toljevac, Karanovac, Mala Kruševica, Zalogovac, Marenovo, and Parcane) are located in the zone from 200 to 350 m above sea level, which favors the development of fruit growing (strawberries, blackberries, raspberries), viticulture, but also livestock breeding. There are several cold stores on the territory of Varvarin municipality, but it is necessary to expand the capacities (ЈУГИНУС, 2009).

The most promising settlement in terms of viticulture is Bačina, where the famous winery "Bačina vino" is located, which markets its products on the Swedish market. Of the vegetable crops, peppers are grown the most, but an increasing number of farmers plant gherkins due to pre-contracted purchases, and there are also tomatoes, cabbage, and cauliflower. Livestock breeding also has the potential for development. The "Broiler" slaughterhouse, which has been in bankruptcy for a long time, was successfully operating on the territory of Varvarin municipality. However, it is important to mention the Bošnjane settlement, which is known for its poultry farms. The production of laying hens dominates, and there is also the production of broilers, i.e. chickens weighing two to two and a half kilograms. The population of the municipality of Varvarin is mainly engaged in agriculture as a supplemental activity, and its products are used for personal consumption, sold at the market in their settlement, in Varvarin, where the market day is Sunday, or in larger cities such as Kruševac, Paraćin, Jagodina, and Kragujevac.

*Picture 1. Vineyards in the Bačina atar. (photo: N. Josifov, 2022)*



Considering the fragmentation of agricultural holdings and the weak economic power of agricultural producers, of great importance for the development of agriculture and the overall economic development is the association of farmers in agricultural cooperatives, in which the administration of the municipality of Varvarin provides support. At the meetings of the working teams, it was stated that the existing associations and cooperatives in the territory of Varvarin municipality do not have sufficient capacity to support the development of agricultural producers, especially bearing in mind that a certain number of these associations are not even active. That is why it is necessary to intensify efforts in the coming period on the association of agricultural producers, to influence the increase in productivity and volume of production, and to improve their joint position on the placement market. In this way, better purchasing conditions will be ensured, as well as conditions to achieve cooperation with some of the larger business systems that would process agricultural products (План развоја општине Варварин 2021 – 2028). In 2019, the municipality of Varvarin allocated 20 million dinars from the budget for agricultural production subsidies. The idea is to educate farmers so that they know how to use these new funds. The municipality of Varvarin also organizes farmer's trips to agricultural fairs in Novi Sad and Belgrade.

Problems and limitations regarding the development of agriculture in Varvarin municipality are droughts, decrease in the number of inhabitants, fragmentation of plots, and obsolescence of mechanization. Bearing in mind the unfavorable educational structure of agricultural producers, that is, members of agricultural holdings, programs aimed at raising the level of knowledge of agricultural producers about professional services are of great importance for the further development of

agriculture. The municipality of Varvarin, given its size, does not have its service, but belongs to the area of work of the Kruševac Agricultural Expert Service, which performs a wide range of different activities, from introducing modern technologies, giving recommendations for fertilization, various controls, providing expert advice, applying expert measures, up to the activity of helping with the preparation of calculations, business plans, investment programs, etc. However, despite numerous activities, the capacities of PSSS Kruševac are not sufficient to independently lead to the development of agricultural production in the territory of Varvarin municipality. It is necessary to organize educational programs at the level of the territory of the municipality, which would help agricultural producers to improve their products and raise the level of processing (План развоја општине Варварин 2021 – 2028).

Varvarin mostly uses groundwater on the farm for irrigation purposes (86.5%). Therefore, the preservation of the quality of underground water, the application of adequate methods of fertilization, and through construction of a sewage network, and the purification of wastewater, are extremely important for the provision of quality and healthy agricultural species. In the future, Varvarin could look for a solution in the direction of developing organic agriculture.

The Moravian Corridor (Pojate - Preljina highway) will be of vital importance for the municipality of Varvarin when it will be built, as it partly passes through its territory. It will improve the traffic-geographical position of the municipality and make it available for investments, while at the same time enabling faster and easier transportation of agricultural products. In this way, Varvarin will be functionally more significantly connected with the cities in Zapadno Pomoravlje (Kruševac, Trstenik, Kraljevo, Čačak), which are known for being strong economic centers.

### **Conclusion**

By applying the agricultural potential method, it was established that the settlements in river valleys and at lower altitudes (Obrež, Bačina, Bošnjane) have the greatest agricultural potential because the processes of depopulation and deagrarianization are more intense at higher altitudes. The second hypothesis, that agriculture is dominant, was also confirmed. The last hypothesis is disputed because the agricultural potential at the settlement level is not most correlated with the average age of the population, but with the number of the agricultural population and the number of inhabitants (very high correlation  $r = 0.92$  for the correlation with the number of agricultural population per settlement and  $r = 0.85$  for the number of inhabitants per settlement). The main factor on which the state of agriculture in the municipality of Varvarin depends is anthropogenic influence. It manifests itself in the form of demographic characteristics of the population (number, economic

structure, population age), which are not favorable due to depopulation and aging of the population, and ways of managing space and available resources, which for now are not only not used by the available possibilities, but are also marginalized and ignore.

The main limitation of this study is contained in the absence of temporal continuity of the database, to be able to see long-term trends in the analyzed processes and apply models for projections in the future. It is also necessary to consider the time dimension in which the processes of deagrarization took place and intensified. Another shortcoming in this work is the absence of a systematic approach and analysis of the agriculture of the Varvarin as part of the area, region, and state, i.e. its role and importance at different levels (local, regional, national). By applying the comparative method (comparison of the agricultural potential of the municipality of Varvarin with neighboring municipalities and its ranking at the regional and national level), one would gain an insight into its position about the environment, advantages and disadvantages about neighboring municipalities, as well as the potentials that make it unique and which could be used for the revitalization of agriculture.

In future research, the development of agriculture and the agricultural potential of the municipality of Varvarin could be linked to the quantification of physical-geographical conditions and processes (the relationship between agricultural production and altitude, terrain slope, terrain exposure, erosive processes, soil types, and quality, dry/wet years, natural disasters) and population structures (economic, educational, gender-age population structure). In addition to the mentioned segments, the plan is to use satellite images for a longer period, with the help of which it would be possible to see the changes that have occurred.

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### References

- Abdelsamie, E.A.; Abdellatif, M.A.; Hassan, F.O.; El Baroudy, A.A.; Mohamed, E.S.; Kucher, D.E.; Shokr, M.S. (2023). Integration of RUSLE Model, Remote Sensing and GIS Techniques for Assessing Soil Erosion Hazards in Arid Zones. *Agriculture*, 13(35). <https://doi.org/10.3390/agriculture13010035>
- Baaken, M. C. (2022). Sustainability of agricultural practices in Germany: a literature review along multiple environmental domains. *Regional Environmental Change*, 22(2), 39. <https://doi.org/10.1007/s10113-022-01892-5>
- Babović, S., Lović-Obradović, S., & Prigunova, I. (2016). Depopulation of villages in southeastern Serbia as hindrance to economic development. *Journal of the Geographical Institute "Jovan Cvijic"*, SASA, 66(1), 61-74.
- Bachev, H. (2019). *Evolution of agrarian research and development in Bulgaria during country's EU Membership*. Available at SSRN 3551149.
- Bačević, N. R., Milentijević, N. M., Valjarević, A., Gicić, A., Kićović, D., Radaković, M. G., ... & Pantelić, M. (2021). Spatiotemporal variability of air temperatures in Central Serbia from 1949 to 2018. *IDŐJÁRÁS/QUARTERLY JOURNAL OF THE HUNGARIAN METEOROLOGICAL SERVICE*, 125(2), 229-253.
- Battino, S., & Lampreu, S. (2019). The role of the sharing economy for sustainable and innovative development of rural areas: A case study in Sardinia (Italy). *Sustainability*, 11(11), 3004.
- Bluman, A. G. (2009). *Elementary statistics: A step by step approach*. New York, NY: McGraw-Hill Higher Education.
- Bogunović, I., Viduka, A., Magdić, I., Telak, L. J., Francos, M., & Pereira, P. (2020). Agricultural and forest land-use impact on soil properties in Zagreb Periurban Area (Croatia). *Agronomy*, 10(9), 1331.
- Bogunović, I., Telak, L. J., & Pereira, P. (2020). Experimental comparison of runoff generation and initial soil erosion between vineyards and croplands of Eastern Croatia: A case study. *Air, Soil and Water Research*, 13, 1178622120928323.
- Bubalo-Živković, M., Kalenjuk, B., Lukić, T., & Đerčan, B. (2018). Who Is Still Engaged in Agriculture in Vojvodina?. *European Geographical Studies*, (5), 32-41. DOI: 10.13187/egs.2018.1.32
- Dašić, B., & Labović, B. (2020, September). Agrarian and tourist potential of rural areas in Serbia. In *Tourism International Scientific Conference Vrnjačka Banja-TISC* (Vol. 5, No. 2, pp. 130-146).
- Diaz-Sarachaga, J. M. (2020). Combining participatory processes and sustainable development goals to revitalize a rural area in Cantabria (Spain). *Land*, 9(11), 412.
- Ghadami, M., Dittmann, A., Pazhuan, M., & Aligholizadeh Firouzjaie, N. (2022). Factors Affecting the Change of Agricultural Land Use to Tourism: A Case Study



- on the Southern Coasts of the Caspian Sea, Iran. *Agriculture*, 12(1), 90. <https://doi.org/10.3390/agriculture12010090>
- Gocić, M., Dragičević, S., Radivojević, A., Martić Bursać, N., Stričević, Lj., & Đorđević, M. (2020). Changes in soil erosion intensity caused by land use and demographic changes in the Jablanica River Basin, Serbia. *Agriculture*, 10(8), 345.
- Gruchelski, M., & Niemczyk, J. (2020). Developmental needs of the polish agri-food sector and the proposed actions under the common agricultural policy of the European Union®. *Postępy Techniki Przetwórstwa Spożywczego*.
- Guth, M., Smędzik-Ambroży, K., Czyżewski, B., & Stępień, S. (2020). The economic sustainability of farms under common agricultural policy in the European union countries. *Agriculture*, 10(2), 34.
- Horvat, U., & Žiberna, I. (2020). The correlation between demographic development and land-use changes in Slovenia. *Acta geographica Slovenica*, 60(2), 33-55.
- Joksimović, M. & Golić, R. (2021). Depopulationi procesi u Srbiji u 21. veku – od lokalnog do nacionalnog problema. *Planska i normativna zaštita prostora i životne sredine*, Asocijacija prostornih planera Srbije, Univerzitet u Beogradu – Geografski fakultet, Beograd.
- ЛУГИНУС (2009). *Просторни план општине Варварин*. Варварин: Скупштина општине Варварин.
- Kertész, Á., Nagy, L. A., & Balázs, B. (2019). Effect of land use change on ecosystem services in Lake Balaton Catchment. *Land Use Policy*, 80, 430-438.
- Krstić, F., & Paunović, S. (2022). Changes in soil erosion intensity in Jablanica region. *Zbornik radova-Geografski fakultet Univerziteta u Beogradu*, (70), 83-93. doi: 10.5937/zrgfub2270083K
- López, M., Cazorla, A., & Panta, M. D. P. (2019). Rural entrepreneurship strategies: Empirical experience in the Northern Sub-Plateau of Spain. *Sustainability*, 11(5), 1243.
- Ljubojević, R., Blanuša, A., & Petrović, S. (2022). Agrarian strategy and policy of the Republic of Serbia. *Ekonomika poljoprivrede*, 69(3), 897-909. doi:10.5937/ekoPolj2203897L
- Manojlović, S., Antić, M., Sibinović, M., Dragičević, S., & Novković, I. (2017). Soil erosion response to demographic and land use changes in the Nišava river basin, Serbia. *Fresenius Environmental Bulletin*, 26, 7547-7560.
- Manojlović, S., Sibinović, M., Srejić, T., Hadud, A., & Sabri, I. (2021). Agriculture land use change and demographic change in response to decline suspended sediment in Južna Morava River basin (Serbia). *Sustainability*, 13(6), 3130.
- Manojlović, S., Srejić, T., Sibinović, M., Milošević, M. V., Bajat, B., & Kostadinov, S. (2022). Impact of precipitation and human activities on suspended sediment

- transport load in the Velika Morava River Basin (Serbia). *Arabian Journal of Geosciences*, 15(13), 1209. <https://doi.org/10.1007/s12517-022-10475-x>
- Martinović, M., & Ratkaj, I. (2015). Sustainable rural development in Serbia: Towards a quantitative typology of rural areas. *Carpathian journal of earth and environmental sciences*, 10(3), 37-48.
- Michler, J. D., Baylis, K., Arends-Kuenning, M., & Mazvimavi, K. (2019). Conservation agriculture and climate resilience. *Journal of environmental economics and management*, 93, 148-169. <https://doi.org/10.1016/j.jeem.2018.11.008>
- Mićković, B., Mićanović, D., Spalević, V., Škatarić, G., & Dudić, B. (2020). Contribution to the analysis of depopulation in rural areas of the Balkans: Case study of the Municipality of Niksic, Montenegro. *Sustainability*, 12(8), 3328.
- Milanović, M. R., Stevanović, S., & Dimitrijević, B. (2016). AGRARIAN POTENTIALS IN THE REINDUSTRIALIZATION OF SERBIA – import of inputs and the opportunity costs of development. *Економика пољопривреде*, 63(1), 143-158. UDC 631.1:303.442.3(497.11)
- Милинчић, М., Туцовић, М., & Мандић, Б. (2013). Неки аспекти утицаја пољопривреде на животну средину. *Зборник радова–Географски факултет Универзитета у Београду*, 61, 31-58. УДК 338.43:502.17
- Milovanović, B., Stanojević, G., & Radovanović, M. (2022). Climate of Serbia. *The Geography of Serbia: Nature, People, Economy*, 57-68.
- Negese, A. (2021). Impacts of land use and land cover change on soil erosion and hydrological responses in Ethiopia. *Applied and Environmental Soil Science*, 2021.
- Novković, I., Dragičević, S., & Djurović, M. (2022). Geohazard and Geoheritage. *The Geography of Serbia: Nature, People, Economy*, 119-131.
- Pawlak, K., Smutka, L., & Kotyza, P. (2021). Agricultural potential of the EU countries: how far are they from the USA?. *Agriculture*, 11(4), 282. <https://doi.org/10.3390/agriculture11040282>
- Pazúr, R., Lieskovský, J., Feranec, J., & Ořahel, J. (2014). Spatial determinants of abandonment of large-scale arable lands and managed grasslands in Slovakia during the periods of post-socialist transition and European Union accession. *Applied Geography*, 54, 118-128.
- Pavlović, P., Kostić, N., Karadžić, B., Mitrović, M. (2017). *The soils of Serbia*. Springer. DOI: 10.1007/978-94-017-8660-7
- Pénzes, J., Pásztor, I. Z., & Tátrai, P. (2015). Demographic processes in developmentally peripheral areas of Hungary. *Demography*, 53(2), 87-111.
- Петровић, А. (2021). *Бујичне поплаве у Србији – посебна издања књига 73*. Београд: Српско географско друштво.
- План развоја општине Варварин 2021-2028, Варварин (2021).



- Plana-Farran, M., & Gallizo, J. L. (2021). The survival of family farms: Socioemotional wealth (SEW) and factors affecting intention to continue the business. *Agriculture*, 11(6), 520. <https://doi.org/10.3390/agriculture11060520>
- Prishchepov, A. V., Schierhorn, F., & Löw, F. (2021). Unraveling the diversity of trajectories and drivers of global agricultural land abandonment. *Land*, 10(2), 97.
- Radaković, M. G., Tošić, I., Bačević, N., Mladjan, D., Gavrilov, M. B., & Marković, S. B. (2018). The analysis of aridity in Central Serbia from 1949 to 2015. *Theoretical and applied climatology*, 133, 887-898. *IDŐJÁRÁS/QUARTERLY JOURNAL OF THE HUNGARIAN METEOROLOGICAL SERVICE*, 125(2), 229-253.
- Rajczi, A., Vörös, P., & Dajnoki, K. (2017). Human resource aspect of agricultural economy—challenges of demographic change. *APSTRACT: Applied Studies in Agribusiness and Commerce*, 11(1033-2018-2966), 163-168. DOI: 10.19041/APSTRACT/2017/3-4/22
- Раткај, И. & Сибиновић, М. (2012). Продуктивност пољопривреде у сеоским насељима региона Београда. У: Грчић, М. & Милинчић, М. (ур). *Проблеми и изазови савремене науке и наставе географије*. 385-392. УДЦ: 338.312:631(497.11).
- Републички завод за статистику (2012). *Становништво према полу и старости 2011* (књига 2). Београд: Републички завод за статистику.
- Републички завод за статистику (2014). *Упоредни преглед броја становника 1948-2011* (књига 20). Београд: Републички завод за статистику.
- Републички завод за статистику (2014). *Упоредни преглед броја домаћинства 1948-2011* (књига 21). Београд: Републички завод за статистику.
- Републички завод за статистику. *Општине и региони у Србији* (2012). Београд: Републички завод за статистику.
- Републички завод за статистику (2015). *Потпис пољопривреде 2012. године*. Београд: Републички завод за статистику.
- Сибиновић, М. & Лазић, И. (2013). Просторна дистрибуција биљне производње у руралном простору Региона Београда. У: *Планска и нормативна заштита простора и животне средине*. Београд: АППС, 147-152.
- Сибиновић, М. (2014). *Структурне промене и просторна диференцијација пољопривреде у сеоским насељима региона Београда*. (Докторска дисертација). Београд: Универзитет у Београду – Географски факултет.
- Sibinović, M. (2015). Typology of agriculture in conditions of transitional crisis: The case of the Belgrade region. *Zbornik radova-Geografski fakultet Univerziteta u Beogradu*, (63), 81-118. doi: 10.5937/zrgfub1563081S
- Sibinović, M. (2012). Structural changes in the rural planting areas of Belgrade region. *Bulletin of the Serbian geographical society*, 92(2), 112-132. DOI: 10.2298/GSGD1202111S

- Стаменковић, С. (2001). *Географска енциклопедија насеља Србије (књига I)*. Београд: Географски факултет.
- Степић, М. и Јаћимовић, Б. (2006). *Основи аграрне географије*. Београд: Јантар група.
- Stojanović, Ž. (2022). Agriculture in Serbia. *The Geography of Serbia: Nature, People, Economy*, 199-206.
- Tianming, G. A. O., Ivolve, A., & Erokhin, V. (2018). Sustainable rural development in northern China: Caught in a vice between poverty, urban attractions, and migration. *Sustainability*, 10(5), 1467.
- Vaishar, A., Vavrouchová, H., Lešková, A., & Peřinková, V. (2021). Depopulation and extinction of villages in Moravia and the Czech Part of Silesia since World War II. *Land*, 10(4), 333.
- Villoria, N. B., Byerlee, D., & Stevenson, J. (2014). The effects of agricultural technological progress on deforestation: What do we really know? *Applied Economic Perspectives and Policy*, 36(2), 211–237. <https://doi.org/10.1093/aep/ppy005>
- Viñas, C. D. (2019). Depopulation processes in European rural areas: a case study of Cantabria (Spain). *European Countryside*, 11(3), 341-369.
- Wegren, S. K. (2016). The quest for rural sustainability in Russia. *Sustainability*, 8(7), 602.
- Wojewódzka-Wiewiórska, A. (2019). Depopulation in rural areas in Poland—Socio-economic local perspective. *Research for Rural Development*, 2, 126-132.
- Yarashynskaya, A., & Prus, P. (2022). Precision Agriculture Implementation Factors and Adoption Potential: The Case Study of Polish Agriculture. *Agronomy*, 12(9), 2226. <https://doi.org/10.3390/agronomy12092226>
- Zagata, L., Hrabák, J., & Lošřák, M. (2020). Post-socialist transition as a driving force of the sustainable agriculture: A case study from the Czech Republic. *Agroecology and Sustainable Food Systems*, 44(2), 238-257. <https://doi.org/10.1080/21683565.2019.1585400>
- Zhichkin, K., Nosov, V., & Zhichkina, L. (2021). Agrarian potential of personal subsidiary plots. In BIO Web of Conferences (Vol. 37, p. 00190). *EDP Sciences*. <https://doi.org/10.1051/bioconf/20213700190>
- Živanović, V., Joksimović, M., Golić, R., Malinić, V., Krstić, F., Sedlak, M., & Kovjanić, A. (2022). Depopulated and Abandoned Areas in Serbia in the 21st Century—From a Local to a National Problem. *Sustainability*, 14(17), 10765. <https://doi.org/10.3390/su141710765>