POPULATION DYNAMICS OF THE SETTLEMENTS AND DISTANCE FROM THE CITY CENTER: CASE STUDY OF THE CITY OF SMEDEREVO

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Abstract: The main idea of this article is to investigate the correlation between the distance of the settlement from the city center on the one hand and the dynamics of the natural growth rate and net migration on the other, which would determine the range of positive demographic influence of the urban settlement on its immediate surroundings. In the analysis, mainly demographic and geographical methods were used, supplemented by the statistical method of simple linear correlation. The results show that the range of positive demographic influence of the urban settlement extends up to a distance of 12 kilometers for the rate of natural growth and 14 kilometers for the rate of net migration. The importance of distance for the rate of natural increase increased over time, while the importance of distance for the rate of net migration decreased. The correlation analysis confirmed a moderately strong inverse (negative) relationship between the distance of the settlement from the city center. The positive demographic influence of the urban settlement extends to the area north of the E-75 highway and the state road of the first B category (Belgrade – Požarevac) No. 33, which roughly coincides with the Danube belt of the Smederevo urban area, with the exception of settlements that are not characterized by transport transitivity and functional integration into the urban/municipal system.

Keywords: Smederevo, distance, population dynamics, settlements, net migration, natural increase.

Introduction

The City of Smederevo is located in central Serbia, on the border with Šumadija, Pomoravlje and the Pannonian Plain. It comprises 28 settlements with a population

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of 97,930 according to the 2022 census. These settlements are characterized by certain mutual differences, which become apparent when analyzing the physical-geographical, economic, functional and socio-economic characteristics. The area of the city can be conditionally divided into three larger geographical units: the Danube belt (the part of the city that extends between the Danube and the Ralja River, i.e. north of the highway), the Pomoravlje belt (the part of the city that extends in the alluvial plains of Velika Morava and Jezava), the Šumadija belt (the part of the city that includes the gently indented surface of the Šumadija area) (Figure 1).
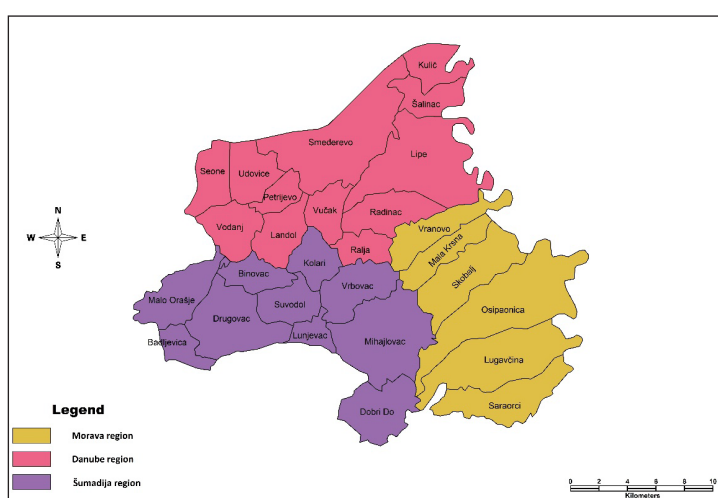

Figure 1. Geographical units of the City of Smederevo

The Danube belt includes the urban settlement of Smederevo, the suburban settlements of Udovice, Petrijevo, Landol, Vučak, Ralja and Radinac (Official Gazette of the Municipality of Smederevo, 2005; Antonić, 2022), all other settlements north of the river Ralja and the highway (Seone, Vodanj and Kolari) and the villages of Lipe, Šalinac and Kulič, which are located near the confluence of the Velika Morava and the Danube. Considering the previous spatial and functional development, the expansion of the built-up area developed in the direction of merging the city and the surrounding (suburban) settlements. In this case, the "border" of the urban fabric with the suburban settlements is represented by the ring road (transit) around the city in the direction of the Belgrade – Smederevo road to the steelworks (Železara), including the settlements that extend along the said road. The Pomoravlje belt consists of several large settlements in the alluvial plains of Velika Morava and Jezava. These settlements are generally compact settlements of the linear type, including Vranovo, Mala Krsna, Skobalj, Osipaonica, Lugavčina and Saraorci. The Šumadija belt consists of rural settlements with a smaller population than the settlements on the Danube and in Pomoravlje, and which are more fragmented and scattered. There

are nine of them (Malo Orašje, Badljevica, Binovac, Drugovac, Suvodol, Lunjevac, Dobri Do, Mihajlovac and Vrbovac). They are located south and southwest of the highway and are mostly situated on hills between 150 and 250 meters above sea level.

Although the geographical characteristics of the urban area of Smederevo did not represent a limitation for the spatial distribution of the population, the basic idea of this work is based on the intention to determine the area of "demographic influence" of the urban settlement on its immediate surroundings. In this sense, the spatial distance and transport connections to the city center are defined as the primary geographical factor for the population dynamics of the settlements in the area of the City of Smederevo.

One of the few domestic papers that directly deals with the relationship between the spatial distance from the urban settlement and population dynamics, the role of transport accessibility on population dynamics and the spatial scope of the positive demographic influence of the urban settlement on its surroundings is the dissertation by Suzana Lović Obradović (2019) entitled "Models of spatial manifestation of demographic processes in Serbia". However, many authors dealt with the population dynamics of settlements as part of local self-government units and emphasised the importance of geographical factors for the spatial distribution of the population (Mihajlović & Novović, 2023; Bratić & Stojiljković, 2015; Stričević, 2015). In addition, some studies pay special attention to the spatial aspect of depopulation and emphasise the peripheral location of settlements and their altitude as very important (Joksimović et al, 2023; Babović, Lović Obradović & Prigunova, 2016). The demographic change of rural areas as the immediate surroundings of urban settlements in the second half of the 20th century in Serbia was a topic that demographers, economists, geographers and sociologists dealt with simultaneously (Radivojević, 1999; Vojković, 2003; Rajković, 2014; Marković, 1986). The demographic impact of cities on the immediate surroundings has also been considered as an important element of population dynamics of settlements through complex systems of daily migration (Nikolić & Mirić, 2018; Lukić, 2011; Stamenković & Gatarić, 2007). In foreign literature, this topic has been discussed in relation to economic development (Salvia et al., 2020), distances and transport accessibility (Stjernberg & Penje, 2019), population concentration poles (Kupiszewski et al., 1998) and the availability and accessibility of services in cities (Linard et al., 2012).

In this case, the topic investigated in this thesis can be considered as an independent scientific contribution, as there are no such studies in the domestic literature that attempt to determine the area of positive demographic impact of the city on the surrounding settlements in its administrative area in this specific way.

Methodology

Various scientific methods were used to test the initial hypothesis that the proximity and good transport links to the urban settlement have a positive effect on the population dynamics of the surrounding settlements. Among the methods used, demographic and geographical methods of scientific analysis dominate. The demographic research method refers to a specific method of studying the population of the observed area, which is used in combination with a mathematical-statistical method whose main task is to identify and quantify the relationship between demographic and geographical variables. To this end, a correlation analysis was carried out to determine the degree of quantitative linear correspondence between different demographic components of population growth as the dependent variable and distance from the city center as the independent variable. By combining these methods, the demographic statistical data was analyzed and processed. To analyze the population dynamics of the settlement, vital statistics data from the documentation tables of the Institute of Statistics of the Republic of Serbia (number of births and deaths at the settlement level) and census statistics data (number, distribution and migration characteristics of the population) were used. In addition, the vital statistics method was also used to calculate net migration at settlement level in the period 1991-2022.

Broadly speaking, the time frame of the study includes the second half of the 20th century and the first two decades of the 21st century, i.e. the period from 1948 to 2022. However, different time frames were used at the different levels of analysis, both in terms of the indicators studied and in terms of spatial coverage. The analysis of the population dynamics of the City of Smederevo as a whole covered the largest period (1948-2022), but the analysis of the components of the city's population growth (natural growth and migration) covered the period from 1961 to 2022, for reasons explained in detail below. The long-term analysis was important for understanding the general demographic context in which the population dynamics of each settlement took place. In addition, the analysis of the components of population growth at settlement level includes the period of the last four censuses (1991-2022), which is also explained in detail below.

Finally, it is necessary to point out two methodological remarks on the data of the Kulič and Šalinac settlements, as well as the reason why the data of the Smederevo settlement were not analyzed. The comments on the Kulič and Šalinac settlements refer to changes in the territorial-administrative division. The settlement of Kulič, although it has existed just as long as the settlement of Šalinac, appeared as a separate unit in the administrative and statistical sense until 1959 and after 2011. In the meantime, the data for Kulič was reported together with the data for Šalinac. Although the official statistics have retroactively extracted the data on the

population of Kulič from the aggregated data for Šalinac, the data on life events from the documentation tables before 2011 cannot be tracked separately. For this reason, the population change indicators for Kulič and Šalinac were calculated together for the period before 2011, but expressed separately in the form of identical values. Finally, the settlement of Smederevo itself was not analyzed, as it is essentially not included in the basic idea of this work, namely the influence of distance from the urban settlement on the population dynamics of the settlement. In this sense, the territorial framework of the study represents the local self-government unit of the town of Smederevo and refers to all settlements other than the City.

Subject and aim of the research

The period under study is characterized by depopulation in most of the settlements observed, although it is assumed that the intensity of depopulation is greater in settlements at a greater distance from the urban settlement, regardless of the direction of change in the number of inhabitants. The main idea of this work is to demonstrate the relationship between the transportation distance (connectivity) and the geographical periphery on the one hand and the intensity of depopulation and the relationship between vital and migratory components of population dynamics on the other. In this sense, natural increase and net migration at the settlement level will be the subject of the study. In the period from the beginning of the 1960s, the urban settlement and other settlements of the peri-urban belt dominantly increased the number of inhabitants due to the migration component, while at the same time the other settlements in the direction of Pomoravlje and the Šumadija belt compensated for the outflow of population through natural growth. At the beginning of the primary analysis period (1991-2022), however, there was a significant decline in economic activity in the area of the city and a generally turbulent social situation in the country. These socio-economic disadvantages can be roughly dated to the period between 1991 and 2002, after which economic activity in the city began to increase again. It is assumed that the settlements that experienced a significant influx of migrants until the 1990s reached a similar socio-economic "level" to other settlements during the said period, bringing them into line in terms of population dynamics. Of course, this claim does not apply to urban settlements. Since 2003, with the resumption of economic activity, the previous differences in the attractiveness of the settlements have reappeared.

Based on this basic assumption, the secondary objective of the study is to identify settlement groups with a dominant influence of migration on population dynamics and to determine the critical distance from the city center (or the center of economic activity) that separates the two mentioned settlement groups.

Demographic context of the population dynamics of the settlements

The course for the urban sprawl of Smederevo was set at the beginning of the 20th century with the founding of the Smederevo Winegrowers' Cooperative (forerunner of the later Godomin Agricultural Combine) in 1909 and the founding of the Serbian Mining and Metallurgical Industry Company (SARTID) in 1913. However, full-scale industrial development did not take place until after the Second World War, particularly with the opening of the Smederevo Metallurgical Combine (Nova železara) in Radinac in 1963. With this in mind, we will follow the population dynamics of the city and observe the acceleration of absolute population growth after the 1961 census (Table 1).

Table 1. Population dynamics of the City of Smederevo in period 1948-2022.

Category	1948	1953	1961	1971	1981	1991	2002	2011	2022
Number of inhabitants	59545	66132	77682	90652	107366	115617	109809	108209	97930
Annual increase rate in ‰	/	20,96	20,08	15,41	16,88	7,40	-4,68	-1,63	-9,07
Absolute annual increase	/	1317	1444	1297	1672	825	-528	-178	-934

Source: Comparative overview of the number of inhabitants 1948-2011, Age and gender in 2022 and author's calculation;

Although the number of inhabitants increased mainly naturally throughout the entire period (up to 1998), the period between 1961 and 1981 is characterised in particular by the extent of immigration. During this period, the population of the city increased by almost 30,000 inhabitants (53.3% due to immigration), and the population of the urban settlement itself more than doubled. In other words, the urban settlement absorbed up to 95% of the population's migratory influx. However, the crisis of the 1990s also coincided with the beginning of open biological depopulation, which is still ongoing. Looking at the period of the last six decades, the city of Smederevo grew almost twice as fast due to the natural component than due to migration. The net migration for the period 1961-2022 amounted to 7095 (35%), while the natural increase amounted to 13153 inhabitants (65%) (Table 2).

Table 2. Natural and migratory component of the population dynamics of the City 1961-2022.

Category	1961/71.	1971/81.	1981/91.	1991/02.	2002/11.	2011/22.	1961-2022
Natural increase	5935	7933	6418	1054	-3226	-4961	13153
Migration balance	7033	8783	1833	-6862	1626	-5318	7095
Average natural increase rate	9,44	8,01	5,76	0,85	-3,12	-4,38	2,44
Average migration balance rate	8,36	8,87	1,64	-5,53	1,57	-4,69	1,31

Source: Comparative overview of the number of inhabitants 1948-2011, Age and gender in 2022, Natural movement of the population 1961-2010, documentation tables and author's calculations;

It is interesting to note that the negative migration balance probably began ten years before the negative natural increase. This assertion is supported by the fact that almost 5% of the population was already working and living abroad in 1991 (5,523 inhabitants), while in the same year the national average was 3.5%. At the same time, natural growth in the City of Smederevo was between 20 % and 100 % higher than in the rest of the country during the observed period (excluding data for Kosovo and Metohija).

The period of the last six decades can be divided into two parts. The period up to 1991, in which the population increased naturally by more than 20,000 and by more than 17,000 due to immigration, and the period after 1991, in which the population decreased by just over 7,000 due to biological depopulation and by more than 10,000 due to immigration. Over the entire period (1961-2022), the average rate of natural increase was 2.44‰, while the average rate of net migration was about twice as low (1.31‰). However, the indirect influence of the immigrant population on fertility levels cannot be overlooked given the large number of immigrants from Kosovo and Metohia. In the last 60 years, almost 35,000 inhabitants have moved to the territory of the city of Smederevo, which, taking into account the positive balance of natural population growth of over 13,000 people, means that about 28,000 people, i.e. almost every third inhabitant, have moved away from the territory of the city in the mentioned period, with an average annual emigration rate of 4.8‰. This makes it necessary to analyse in more detail the period after 2000, which was characterised by a strong outflow of population and negative natural growth. The period after 2000 was characterised not only by extremely negative natural growth and a negative overall migration balance, but also by internal migration, as a result of which the city has lost over 3,000 inhabitants in the last 10 years alone (Table 3). On the other hand, more than 8,000 inhabitants moved into the urban area during this period, which, taking into account the negative migration balance after 2000, means the out-migration of almost 12,000 people.

In the period observed (2000-2022), two turning points can be identified in relation to the movement of natural growth and net internal migration. The first turning point in terms of the evolution of natural growth was in 2005, when negative natural growth fell from -1.66 in 2004 to -3.51 per thousand in 2005. This was due to a methodological change in the registration of live births, as live births to mothers working and living abroad for more than one year were excluded from the records of vital events. Given the high proportion of foreign population in the total population of the City of Smederevo, there was an unnatural decrease in the number of live births by almost 12% during the transition from 2004 to 2005. However, from the gradual decline in the number of live births since 1991, it can be indirectly concluded that the expected decline should have been around 2%, while the remaining 10% is due to the exclusion of the registration of life events of the population abroad.

Table 3. Natural increase and internal migration balance of the City of Smederevo

Year	Estimated population	Natural increase	Internal migration balance	Rate of natural increase	Internal migration rate
2000	110805	-205	-149	-1,85	-1,34
2001	110285	-144	-269	-1,31	-2,44
2002	109767	-145	-117	-1,32	-1,07
2003	109599	-113	67	-1,03	0,61
2004	109431	-182	322	-1,66	2,94
2005	109263	-383	187	-3,51	1,71
2006	109095	-363	76	-3,33	0,70
2007	108927	-425	-33	-3,90	-0,30
2008	108759	-537	-11	-4,94	-0,10
2009	108591	-439	72	-4,04	0,66
2010	108423	-419	-30	-3,86	-0,28
2011	108251	-535	47	-4,94	0,43
2012	107334	-364	-308	-3,39	-2,87
2013	106417	-304	-232	-2,86	-2,18
2014	105500	-374	-246	-3,55	-2,33
2015	104583	-540	-231	-5,16	-2,21
2016	103666	-588	-215	-5,67	-2,07
2017	102749	-573	-332	-5,58	-3,23
2018	101832	-597	-368	-5,86	-3,61
2019	100915	-477	-343	-4,73	-3,40
2020	99998	-762	-330	-7,62	-3,30
2021	99081	-1067	-195	-10,77	-1,97
2022	98164	-654	-302[2]	-6,66	-3,08
Sum/average	106149	-10190	-2940	-4,24	-1,26

Source: Comparative overview of the number of inhabitants 1948-2011, Age and gender in 2022, Natural population movement 1961-2010, Demographic statistics, documentation tables and author's calculations;

The second turning point relates to the balance of internal migration and can be linked to the year 2012. In the transition from 2011 to 2012, the rate of net internal migration fell from 0.4 to -2.9 per thousand. The expected internal migration balance should have been zero in that year, but amounted to -308 people. One of the main explanations or causes for this negative trend in internal migration is the almost complete cessation of operations of the steel mill in 2011 and the complete cessation of business activities by US Steel at the end of January 2012. The trend reversal in internal migration that began at that time has remained negative to this day, even after the arrival of the new owner, Hesteel Chinese Corporation, in 2016 and the start of production at full capacity, at a rate of around 300 fewer inhabitants per year.

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[2] Estimated balance of internal migration

Ultimately, the last interim census period was unfortunately characterised by the highest overall negative value of the annual growth rate of over -9‰.

Analysis

Natural growth is declining in all settlements in the City of Smederevo, and until the last interim census period there was not a single settlement with positive natural growth. However, not only are there significant differences between settlements in terms of the year in which the negative natural increase began, but also the intensity of biological depopulation varies greatly, which is confirmed by the rates of natural increase (Table 4).

Table 4. Average annual rate of natural increase 1991-2022.

Settlement	1991-2002	2002-2011	2011-2022	1991-2022
Badljevica	-3,7	-12,2	-14,3	-9,4
Binovac	-12,1	-13,3	-11,8	-10,5
Vodanj	-2,2	-10,7	-11,7	-7,6
Vranovo	1,5	-1,0	-4,7	-1,3
Vrbovac	-5,3	-6,9	-10,6	-7,3
Vučak	3,1	-1,6	-2,5	-0,5
Dobri Do	-1,3	-9,8	-13,7	-7,3
Drugovac	-7,9	-10,3	-9,3	-8,8
Kolari	2,4	-7,4	-8,0	-4,0
Kulič	-6,1	-14,3	-16,4	-11,4
Landol	-6,2	-7,4	-6,3	-6,5
Lipe	-3,3	-5,8	-7,6	-5,1
Lugavčina	-0,7	-8,4	-10,5	-5,6
Lunjevac	-6,1	-9,9	-12,8	-9,9
Mala Krsna	4,0	-3,1	-4,5	-0,9
Malo Orašje	-4,7	-11,0	-12,0	-8,7
Mihajlovac	-4,5	-7,6	-11,3	-7,2
Osipaonica	1,0	-7,5	-11,1	-4,6
Petrijevo	-1,6	-3,4	-3,9	-3,0
Radinac	4,6	0,5	-2,5	0,9
Ralja	0,9	1,1	-1,5	0,2
Saraorci	-2,1	-6,8	-8,4	-5,3
Seone	-1,6	-7,1	-5,9	-4,9
Skobalj	0,8	-7,1	-12,3	-5,2
Suvodol	-7,4	-7,7	-10,4	-8,3
Udovice	2,5	-5,3	-6,7	-2,9
Šalinac	-6,1	-14,3	-16,4	-11,4
Total/average	**-1,0**	**-5,8**	**-7,8**	**-4,6**

Source: Author's calculation

No less than 13 settlements of the City of Smederevo entered the observed period with advanced biological depopulation, making up 16% of the total population of the city. In the first five-year period (1991-1995), five more settlements were added, now making up 24% of the city's total population. By the end of the 20th century, 22 settlements in the City of Smederevo had negative natural growth, and the total population of the City showed negative growth values for the first time in 1998. At that time, almost 4/5 of the settlements and almost 1/3 of the population recorded negative natural growth. In the period from 2001 to 2005, Vranovo, Vučak, Mala Krsna and the town itself joined this group, bringing 95% of the population into biological depopulation. The remaining two settlements, Radinac and Ralja, have been facing negative natural growth since 2007 and 2012, and together with 26 other settlements, they have lost 8,644 people biologically by the 2022 census (Table 5).

Table 5. Year when biological depopulation started[3]

Period	Number of settlements	Distance	Name of settlement
1990. and before	13	14,2km	Badljevica, Binovac, Vodanj, Vrbovac, Dobri Do, Drugovac, Kulič, Landol, Lipe, Lunjevac, Mihajlovac, Suvodol, Šalinac
1991-1995.	5	15,8km	Lugavčina, Malo Orašje, Petrijevo, Saraorci, Seone
1996-2000.	4	12,3km	Kolari, Osipaonica, Skobalj, Udovice
2001-2005.	4	8,3km	Vranovo, Vučak, Mala Krsna
2006. and after	2	8,0km	Radinac, Ralja

Source: Author's calculation

Although the entire urban area shows more favorable values for the natural growth rate on average than the national average, the differences between the individual settlements are considerable. In the first interim survey period (1991-2002), nine settlements had an average annual natural growth rate with positive values, two in 2002-2011 and none in 2011-2022. However, looking at the overall period 1991-2022, only two settlements (Radinac and Ralja) recorded positive average annual rates of natural growth, with only 0.9‰ and 0.2‰ respectively. Since the differences in the observed indicators between the settlements are large, they are presented on the basis of four categories.

The main result of the analysis shows that the values of natural increase are decreasing over time, with the decrease being much more intense in settlements

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[3] The table does not show the year in which negative natural growth was recorded for the first time, thus empirical values were smoothed (with a linear or parabolic function) in order to avoid random oscillations due to the low frequency of the observed phenomenon.

further away from the city center (Table 6). Although fertility rates have not decreased significantly in the last 10 years, the increase in mortality due to the two and a half years of the Covid-19 crisis and the aging of the population have had a negative impact on the values of the natural increase rate. In addition, Smederevo belongs to a group of cities where life expectancy for both sexes has also decreased in the last decade, which additionally affects the deepening of the difference between the number of births and the number of deaths on an annual basis.

Table 6. Categories of settlements according to the rate of natural increase and average distance from the city center

Period	> 0	-5 to 0	-10 to -5,1	< -10
1991-2002.	Vranovo, Vučak, Kolari, Mala Krsna, Osipaonica, Radinac, Ralja, Skobalj, Udovice (**10,0km**)	Badljevica, Vodanj, Dobri Do, Lipe, Lugavčina, Malo Orašje, Mihajlovac, Petrijevo, Saraorci, Seone (**16,0km**)	Vrbovac, Drugovac, Kulič, Landol, Lunjevac, Suvodol, Šalinac (**13,0km**)	Binovac (**13,0km**)
2002-2011.	Radinac, Ralja (**8,0km**)	Vranovo, Vučak, Mala Krsna, Petrijevo (**8,0km**)	Vrbovac, Dobri Do, Kolari, Landol, Lipe, Lugavčina, Lunjevac, Mihajlovac, Osipaonica, Saraorci, Seone, Skobalj, Suvodol, Udovice (**14,6**)	Badljevica, Binovac, Vodanj, Drugovac, Kulič, Malo Orašje, Šalinac (**14,6km**)
2011-2022.		Vranovo, Vučak, Mala Krsna, Petrijevo, Radinac, Ralja (**8,0km**)	Drugovac, Kolari, Landol, Lipe, Saraorci, Seone, Udovice (**12,3km**)	Badljevica, Binovac, Vodanj, Vrbovac, Dobri Do, Kulič, Lugavčina, Lunjevac, Malo Orašje, Mihajlovac, Osipaonica, Skobalj, Suvodol, Šalinac (**15,7**)
Average (1991-2022)	**8,0km**	**9,9km**	**16,1km**	**11,7km** (Binovac, Kulič, Šalinac)

Source: Author's calculation

Figure 2, which shows the values of the natural growth rate, clearly shows the spatial regularity in the way its value decreases. In this sense, it seems that the

highway E-75 and the state road of the first B category No. 33 (E-75 – Požarevac) represent the limit for the value and dynamics of natural growth. North of this junction (with the exception of Šalinac and Kulič) there are settlements closer to the city center and with higher values of natural growth, while south of it there are settlements at a greater distance and in the lowest categories of natural growth. North of the mentioned junction there are 14 rural settlements with over 22,000 inhabitants (57.8% of the total rural population of Smederevo) and about half of the urban area. In the period 1991-2002, 7/10 settlements with an above-average natural growth rate were located in the northern part of the urban area. In the period 2002-2011, all 8/8 settlements with above-average natural growth and in the period from 2011 to 2022, 10/10 such settlements were located in the northern part of the urban area of Smederevo. The settlements of the mentioned northern part are in fact settlements belonging to the Danube part of the territory of the city of Smederevo.

As with the analysis of the settlements according to the variability of the natural growth rate, the trends in net migration show a clear mutual differentiation. Taking into account the average annual rates of net migration, it is possible to identify categories (groups) of settlements in terms of the increase/ decrease in the number of inhabitants due to migration and the level of the rate of net migration. The period after 1991 is of particular importance, as during the crisis of the 1990s the city recorded negative
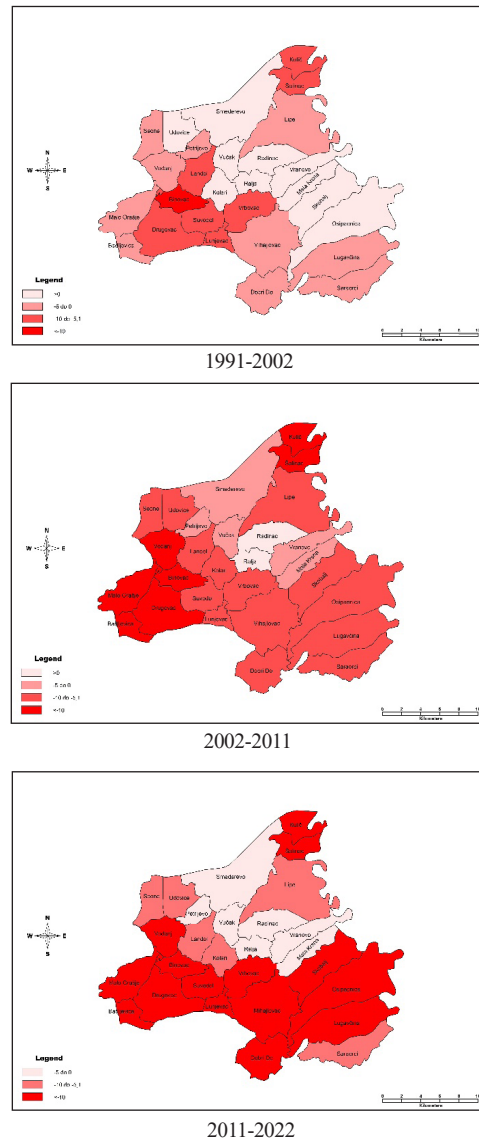

1991-2002

2002-2011

2011-2022

Figure 2. Natural increase rate

net migration for the first time since the Second World War. Moreover, as mentioned above, negative migration trends are "reactivated" after 2012, which means that the total net migration in the period 1991-2022 is -2.6‰, i.e. roughly in line with the values at the national level, which was by no means the case for the City of Smederevo in the second half of the 20th century (Table 7).

Since the average values of the annual net migration at the city level differ considerably in all periods between the censuses (-5.4‰, 1.6‰ and -3.6‰), the ranges of net migration by settlement also differ greatly. However, these differences cannot hide the fact that in the first census period, six settlements had an average net migration rate of more than 10‰, whereas in the second and third census periods, only three settlements each had an average net migration rate of more than 10‰, which obviously speaks for the considerable negative influence of socio-economic conditions on migration movements in the crisis years of the 1990s.

Table 7. Average annual rate of migration balance 1991-2022

Settlements	1991-2002	2002-2011	2011-2022	1991-2022
Badljevica	-2,7	-4,6	-1,3	**-2,9**
Binovac	-31,0	9,4	-4,6	**-10,3**
Vodanj	-5,2	1,7	2,1	**-0,8**
Vranovo	-8,2	1,3	-3,6	**-3,7**
Vrbovac	-3,4	-1,8	-5,4	**-3,5**
Vučak	14,5	15,5	-4,5	**8,1**
Dobri Do	-10,6	-5,0	-2,7	**-6,4**
Drugovac	-2,2	-10,4	-7,5	**-6,1**
Kolari	0,8	-2,5	1,5	**0,0**
Kulič	-8,7	-8,8	9,2	**-3,5**
Landol	16,4	14,3	11,7	**13,8**
Lipe	-9,9	-2,8	-3,4	**-5,5**
Lugavčina	-19,1	-1,6	-7,8	**-10,0**
Lunjevac	-7,4	2,0	-12,0	**-5,8**
Mala Krsna	-7,9	-9,7	4,4	**-4,2**
Malo Orašje	-5,2	-3,3	-5,8	**-4,7**
Mihajlovac	-8,5	-8,4	-3,9	**-6,8**
Osipaonica	-27,0	-6,6	-8,3	**-14,4**
Petrijevo	2,2	33,0	-1,8	**10,0**
Radinac	-6,0	9,9	-10,3	**-2,6**
Ralja	10,3	-26,2	-5,9	**-6,3**
Saraorci	-7,7	-7,4	-10,9	**-8,4**
Seone	11,5	2,8	-1,5	**4,5**
Skobalj	-14,7	-9,0	-0,8	**-8,4**
Suvodol	1,1	-0,1	-1,7	**-0,1**
Udovice	0,2	-4,5	3,0	**-0,3**
Šalinac	-8,7	-8,8	9,2	**-3,5**
City of Smederevo	**-5,4**	**1,6**	**-3,6**	**-2,6**

Positive rate of migration balance
Source: Author's calculation

Four categories were formed to facilitate the analysis of net migration. The first category consists of settlements with an average annual net migration of over 5‰. There are only a few of these settlements, but three suburban settlements (Vučak, Landol and Petrijevo) are particularly noteworthy, with an average annual rate of over 8‰ since the 1991 census. The second category consists of settlements with a positive migration balance, but with values below 5‰. These settlements are also rare, and only two settlements end the entire period in this category (Kolari and Seone). The third and fourth categories include all remaining settlements (22), of which nine settlements have a negative average rate of up to -5‰ and as many as thirteen settlements fall into the above -5‰ category (Table 8). However, the last category is not only the most numerous, but also has a value of over -14‰ and includes almost half of the total population of rural settlements (47.1 %).

Table 8. Categories of settlements according to the rate of migration balance

Period	> 5	0 to 5	-5 to < 0	< -5
1991-2002.	Vučak, Landol, Ralja, Seone **(8,5km)**	Kolari, Petrijevo, Suvodol, Udovice **(9,3km)**	Badljevica, Vrbovac, Drugovac **(18,0km)**	Binovac, Vodanj, Vranovo, Dobri Do, Kulič, Lipe, Lugavčina, Lunjevac, Mala Krsna, Malo Orašje, Mihajlovac, Osipaonica, Radinac, Saraorci, Skobalj, Šalinac **(14,3km)**
2002-2011.	Binovac, Vučak, Landol, Petrijevo, Radinac **(7,8km)**	Vodanj, Vranovo, Lunjevac, Seone, Šalinac **(11,4km)**	Badljevica, Vrbovac, Dobri Do, Kolari, Lipe, Lugavčina, Malo Orašje, Suvodol, Udovice **(15,1km)**	Drugovac, Kulič, Mala Krsna, Mihajlovac, Osipaonica, Ralja, Saraorci, Skobalj **(15,3km)**
2011-2022.	Kulič, Landol, Šalinac **(10,0km)**	Vodanj, Kolari, Mala Krsna, Udovice **(9,3km)**	Badljevica, Binovac, Vranovo, Vučak, Dobri Do, Lipe, Mihajlovac, Petrijevo, Seone, Skobalj, Suvodol **(13,1km)**	Vrbovac, Drugovac, Lugavčina, Lunjevac, Malo Orašje, Osipaonica, Radinac, Ralja, Saraorci **(15,9km)**
Prosek (1991-2022)	Vučak, Landol, Petrijevo **(6,7km)**	Kolari, Seone **(10,5km)**	Badljevica, Vodanj, Vranovo, Vrbovac, Mala Krsna, Malo Orašje, Radinac, Suvodol, Udovice **(12,0km)**	Binovac, Dobri Do, Drugovac, Kulič, Lipe, Lugavčina, Lunjevac, Mihajlovac, Osipaonica, Ralja, Saraorci, Skobalj, Šalinac **(15,8km)**

Source: Author's calculation

In any case, most settlements are characterized by an unfavorable migration flow, and the settlements in the immediate vicinity of the city center have the most positive values of net migration. In contrast, the most negative values of net migration are recorded in the most distant settlements and in the settlements outside the main transport axes.

The aforementioned components of population change influenced the dynamics of population growth in such a way that the settlements (according to population size categories) were increasingly concentrated in the lower categories. The essence of this change can be seen in the fact that the share of population in settlements with more than 3,000 inhabitants decreased by more than 30 percentage points, the share of population in settlements between two and three thousand inhabitants increased from 1/5 to 1/3, in settlements with 1,000 to 2,000 inhabitants increased by 12 percentage points, while in settlements with 500 to 1,000 inhabitants the increase amounted to 2 percentage points, as well as in the smallest settlements (Table 9).

The settlement size depicted in Figure 3 shows the trend in population dynamics over the last 30 years, which can be briefly described by stating that the settlements in the eastern part of the urban area are most responsible for the overall negative trends in the demographic development of the area under consideration. However, a closer look at the map shows that the greatest population decline is to be found in settlements at a greater distance from the city center, as well as in settlements that are not characterized by traffic permeability, regardless of their relative proximity to the city center.

Table 9. Categories of settlements according to population size

| Year	> 3000	2000 to 3000	1000 to 2000	500 to 1000	< 500
1991.	Lipe, Lugavčina, Mihajlovac, Osipaonica, Radinac (42,6%)	Vranovo, Drugovac, Saraorci, Skobalj (19,1%)	Vodanj, Vrbovac, Vučak, Dobri Do, Kolari, Mala Krsna, Malo Orašje, Petrijevo, Ralja, Udovice (27,0%)	Binovac, Landol, Lunjevac, Seone, Suvodol, Šalinac (9,7%)	Badljevica, Kulič (1,6%)
2002.	Lipe, Lugavčina, Mihajlovac, Osipaonica, Radinac (40,0%)	Vranovo, Saraorci, Udovice (15,1%)	Vodanj, Vrbovac, Vučak, Dobri Do, Drugovac, Kolari, Landol, Mala Krsna, Malo Orašje, Petrijevo, Ralja, Skobalj, (35,8%)	Lunjevac, Seone, Suvodol, Šalinac (6,6%)	Badljevica, Binovac, Kulič (2,5%)
2011.	Lipe, Lugavčina, Osipaonica, Radinac (34,4%)	Vranovo, Mihajlovac, Saraorci (16,9%)	Vodanj, Vrbovac, Vučak, Drugovac, Kolari, Landol, Lunjevac, Mala Krsna, Petrijevo, Ralja, Skobalj, Udovice(35,4%)	Dobri Do, Malo Orašje, Seone, Suvodol, Šalinac (11,0%)	Badljevica, Binovac, Kulič (2,3%)
2022.	Radinac (12,2%)	Vranovo, Lipe, Lugavčina, Mihajlovac, Osipaonica (33,2%)	Vodanj, Vučak, Drugovac, Kolari, Landol, Mala Krsna, Petrijevo, Ralja, Saraorci, Skobalj, Udovice, (39,4%)	Vrbovac, Dobri Do, Malo Orašje, Šalinac, Seone, Suvodol (11,8%)	Badljevica, Binovac, Kulič, Lunjevac (3,4%)

Source: Author's calculation
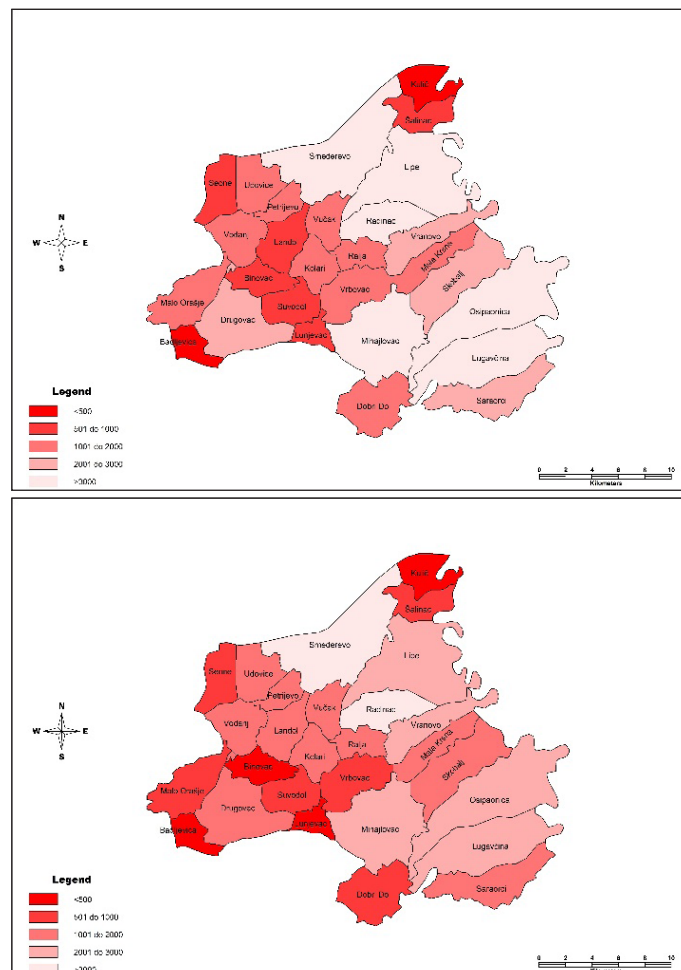
Figure 3. Population size of settlements of the City of Smederevo in 1991 and 2022

Results

As it was stated in the previous text that the initial hypothesis of the work is that the level of the natural increase rate and net migration depends on the geographical location of the settlement, i.e. the distance from the urban settlement, in the following text we will analyze the change of the mentioned rates depending on the distance from the urban settlement of Smederevo. We will divide the settlements of the City of Smederevo, 27 of them without an urban settlement, into four categories according to the distance from the city center.

The largest number of settlements is located in the immediate vicinity of the city center, i.e. there are up to ten settlements at a distance of up to 10 km. The next category of settlements at a distance of more than 10 and less than 15 kilometers consists of eight settlements, the category of distances of more than 15 to less than 20 kilometers consists of five settlements and the last category of settlements at a distance of 20 or more kilometers consists of only four settlements. Although the number of settlements decreases with the distance from the city center, the distribution of the total number of inhabitants of the settlement according to the distance from the city center is much more significant. Although the population of rural settlements has decreased since 1991 from 51,773 to 38,669 in 2022 (a decrease of 25.3%), this decline has not been uniform and has increased with distance from the city center. The first category of settlements decreased by 8.7%, increasing their share of the total population of rural settlements from 40.6% in 1991 to almost half (49.6%) in 2022. The second category of settlements recorded a decline close to the average, so that their share did not change significantly (17.2% and 16.7% respectively). In the third category, the decline in the number of inhabitants was the sharpest (-41.5%), and the share of the population of these settlements fell from over a quarter in 1991 to less than a fifth in 2022. Finally, the group of the most remote settlements also recorded a very sharp decline in the number of inhabitants by -38.6 %, and the share of the total rural population fell from 1/6 in 1991 to 1/7 in 2022 (Table 10).

Table 10. Distance from the city center and share in the total population of rural settlements

Distance	Settlement	1991.	2002.	2011.	2022.	2022/1991.	Cumulative depopulation 1991-2022[4]
Up to 10 km	Vodanj, Vranovo, Vučak, Kolari, Landol, Lipe, Petrijevo, Radinac, Ralja, Udovice	40,6%	44,3%	47,7%	49,6%	-8,7%	7,5
> 10 to 15km	Binovac, Vrbovac, Kulič, Mala Krsna, Seone, Skobalj, Suvodol, Šalinac	17,2%	17,0%	16,2%	16,7%	-27,5%	31,3
> 15 to < 20km	Drugovac, Lunjevac, Malo Orašje, Mihajlovac, Osipaonica	25,3%	23,0%	21,2%	19,8%	-41,5%	66,8
≥ 20km	Badljevica, Dobri Do, Lugavčina, Saraorci	16,9%	15,7%	14,9%	13,9%	-38,6%	100,0

Source: Author's calculation

The population dynamics analyzed are such that if we calculate the cumulant of the change in the number of inhabitants between 1991 and 2022 and express it as 1, we can say that only 1/13 of the decrease in the number of inhabitants occurred at a distance of up to 10 kilometers, almost 1/3 at a distance of up to 15 kilometers

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[4] Cumulative population decrease from 1991 to 2022 calculated per 100.

and a 2/3 decrease at a distance of up to 20 kilometers from the city center. The remaining third of the decline in the number of inhabitants took place at a distance of more than 20 kilometers. In this sense, Figure 4 clearly shows the differences in the intensity of depopulation depending on the distance of the settlement from the city center.
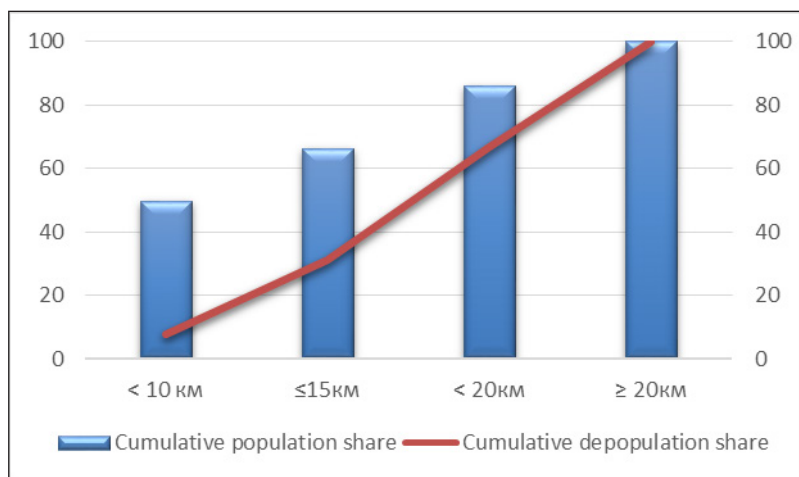

Figure 4. The relation of the share in the population and the share in depopulation

However, since population dynamics depend on the natural and migration components, in the following text we will analyze the change in these components separately depending on the distance to the urban settlement. The downward trend in natural increase is recognizable in all the settlements observed, but not only is the intensity of the change different, but the starting values from which we observe the change are also very different. For example, the range of values for the natural growth rate in 1991 ranged from -12.1‰ in Binovac (13 km away) to 4.6‰ in Radinac (6 km away). The first group of settlements (up to 10 km away) is the only one to record positive values of natural increase, and only during the first interim survey period (1991-2002). Regardless of how we interpret the change in natural growth as a function of distance, the regularity of natural growth, which decreases with increasing distance, is undoubtedly present (Table 11), with the only deviation in the period 1991-2002 being in the group of the most distant settlements, whose natural growth was higher compared to the settlements 10 to 20 km from the city center. Already in the next two intermediate census periods, a regularity increasingly emerges, deepening the difference between closer and more distant settlements. In the period 1991-2002, this difference was 4.0‰, in the period 2002-2011 5.4‰ and in the period 2011-2022 6.1‰. On average, the rate of negative natural growth of the most distant settlements is almost three times higher than that of the closest

settlements over the entire observation period. In addition, the natural growth rate of the group of closest settlements decreased by 5.9‰ during the observation period, the second group by 7.4‰, the third group by 8‰ and the group of furthest settlements by as much as 9.1‰.

The differences in the period in which the negative natural growth occurred can be seen in a slightly different way. Due to a more favorable age structure of the population and somewhat less influenced by differences in the level of fertility rates, the settlements up to 10 km away from the city center managed to maintain positive natural growth for a whole decade longer than the settlements further away.

Table 11. Distance from the city center and average rate of natural increase

Distance	Settlement	1991-2002	2002-2011	2011-2022	2022/1991	Year
Up to 10 km	Vodanj, Vranovo, Vučak, Kolari, Landol, Lipe, Petrijevo, Radinac, Ralja, Udovice	0,9	-3,1	-5,0	-2,3	1997
> 10 to 15km	Binovac, Vrbovac, Kulič, Mala Krsna, Seone, Skobalj, Suvodol, Šalinac	-2,2	-7,5	-9,6	-6,1	1989
> 15 to < 20km	Drugovac, Lunjevac, Malo Orašje, Mihajlovac, Osipaonica	-3,1	-8,5	-11,1	-7,0	1988
≥ 20km	Badljevica, Dobri Do, Lugavčina, Saraorci	-1,4	-8,3	-10,5	-6,2	1988

Source: Author's calculation

If we graph the data on the dynamics of the natural growth rate as a function of the distance of the settlement from the city center, where the distance can be considered as an independent variable and the natural growth rate as a dependent variable, the regularities in the movement of natural growth become clearer (Figure 5). Namely, the graph shows three time periods (periods) and the fourth, which represents the average annual rates of natural growth for the entire observation period (1991-2022). Using the least squares method, the empirical data was smoothed on the basis of a linear function for the dependent variable, while the independent variable was smoothed on the basis of a parabolic function (quadratic parabola). The point at which the two functions intersect represents the "critical distance" above which the values of the natural growth rate are below the average and, conversely, below which they are higher than the average. The aforementioned "critical distance" is around 12 kilometers from the city center.
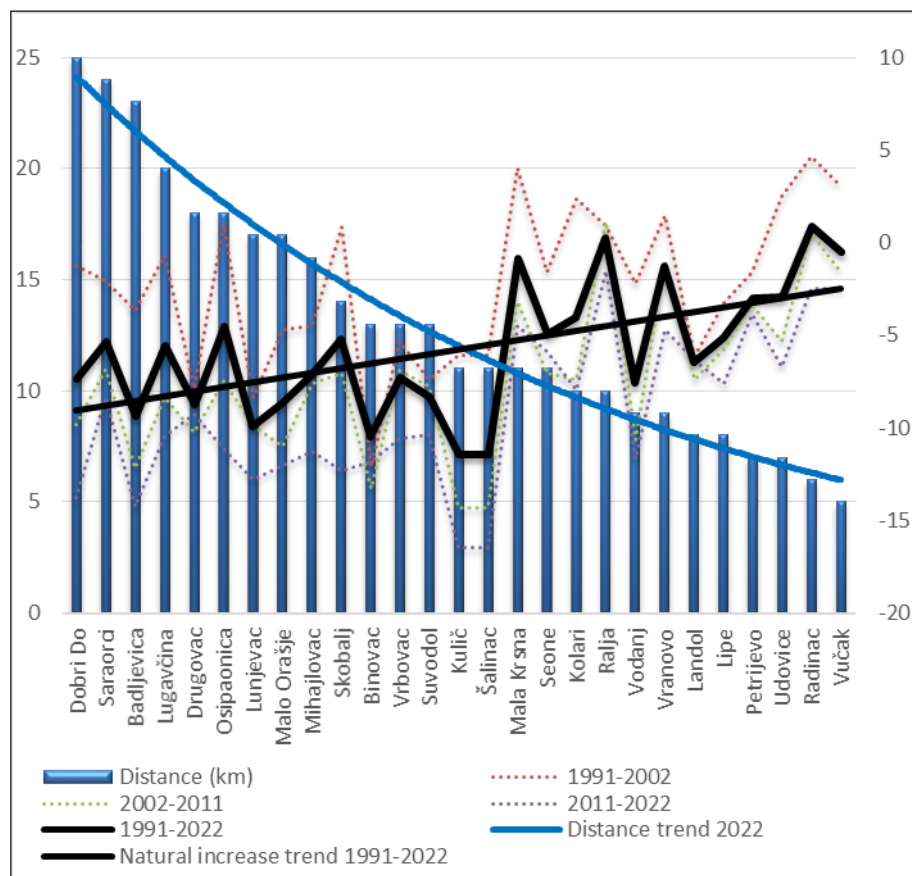
Figure 5. Distance from the urban settlement and rate of natural increase 1991-2022

The coefficient of determination and the correlation coefficient were calculated for a more detailed analysis and to check the linear matching between the two variables. The coefficient of determination indicates what proportion of the empirical data (rate of natural increase) can be directly explained by the change in the independent variable, i.e. the greater the dispersion of the empirical data, the lower the coefficient of determination and vice versa. In this case, the coefficient of determination is 0.365. In other words, 36.5 % of all empirical values of the natural growth rate can be directly explained by the distance of the settlement from the city center. On the other hand, the correlation coefficient indicates the degree of linear quantitative agreement between two variables and can take values from -1 to 1, where the value -1 stands for an ideal inverse (negative) relationship and the value 1 for an ideal direct (positive) relationship. In our case, the correlation coefficient has a value of -0.604, which can be considered a moderate to strong inverse correlation

(Evans, 1996; Hinkle, Wiersma, & Jurs, 2003). Therefore, one can speak of a high degree of agreement between the two observed variables, with a negative correlation between the distance of the settlement from the city center and the value of the natural growth rate. The quantitative analysis of the dynamics of the natural growth rate in relation to the distance of the settlement from the city center acquires its full meaning through the cartographic representation. Figure 6, which shows the value of the natural growth rate by settlement, clearly shows the spatial distribution of the observed phenomenon.

When analyzing the change in net migration as a function of the distance of the settlement from the city center, similar trends are observed, as expected. The value of negative net migration increases with the distance from the city center. In this sense, only 5.2 % of the out-migration of the population took place at a distance of up to 10 km from the city center, 20.6 % at a distance of up to 15 km and 70 % at a distance of up to 20 km. The remaining 30 % took place in settlements that were 20 or more kilometers from the city center (Table 12).

Table 12. Distance from the city center and average rate of migration balance

Distance	Settlement	1991-2002	2002-2011	2011-2022	2022/1991
Up to 10 km	Vodanj, Vranovo, Vučak, Lipe, Kolari, Landol, Petrijevo, Radinac, Ralja, Udovice	-1,8	4,1	-3,3	-0,5
> 10 to 15km	Binovac, Vrbovac, Kulič, Mala Krsna, Skobalj,Seone, Suvodol, Šalinac	-7,5	-4,6	0,5	-4,1
> 15 to < 20km	Drugovac, Lunjevac, Malo Orašje, Mihajlovac, Osipaonica	-14,4	-6,6	-6,8	-10,0
≥ 20km	Badljevica, Dobri Do, Lugavčina, Saraorci	-13,3	-4,2	-7,6	-8,9

Source: Author's calculation

A graphical representation of the data of net migration as a function of the distance of the settlement from the city center (in the same way as for the natural growth rate) reveals regularities in the development (Figure 6). In this case, the "critical distance", above which the values of net migration are below the average and vice versa, below which they are above the average, is around 14 km from the city center. The coefficient of determination in this case is 0.369, i.e. 36.9 % of all empirical values of the net migration rate can be directly explained by the distance of the settlement from the city center. In addition, the correlation coefficient has a value of -0.608, i.e. it stands for a moderate to strong inverse correlation. We can therefore speak of a high degree of agreement between the two observed variables, with a negative correlation between the distance of the settlement from the city center and the level of net migration.
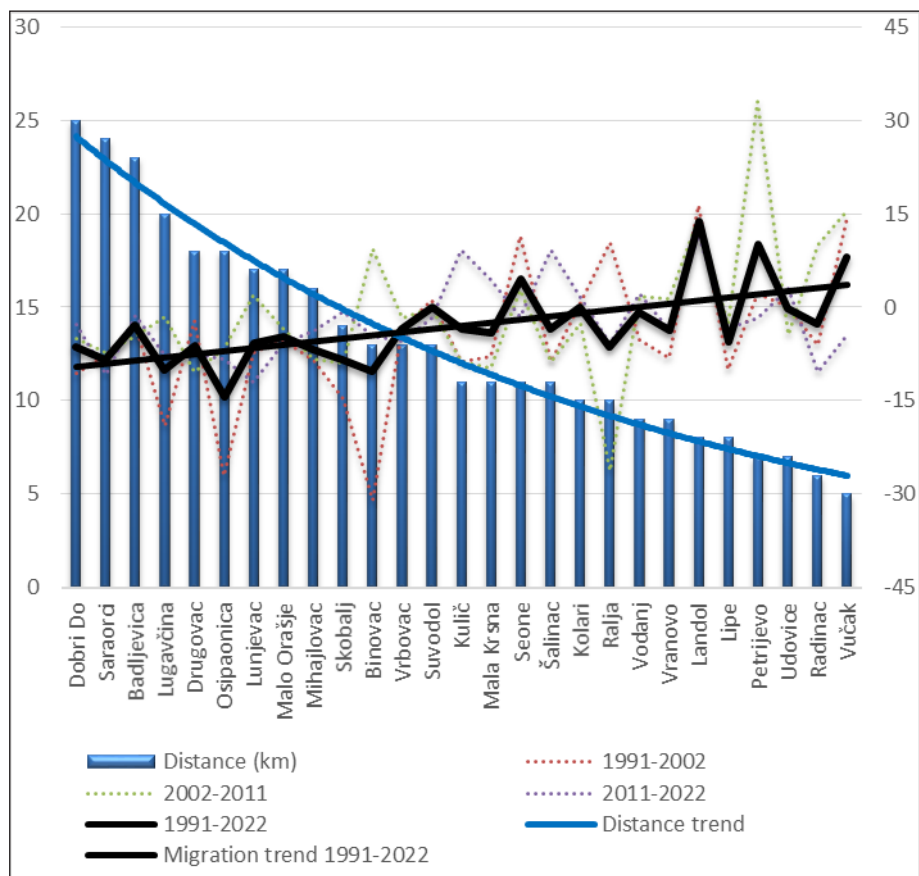
Figure 6. Distance from the urban settlement and rate of migration balance 1991-2022

Discussion

The territorial grouping of economic activities, capital and people is a logical expression of greater economic effects and higher economic growth rates achieved in this way, so that economic growth ultimately implies demographic polarization, as is also the case in Serbia (Vojković, Živanović & Magdalenić, 2018). Such spatial-demographic disparities can also be seen in the example of the lower territorial levels. The example of the City of Smederevo confirms the nature of the relationship between the components of demographic growth and the distance from the municipality/city center. In the conditions of economic and demographic boom after the Second World War, the factor of distance from the city center did not have a negative impact on the increase in the number of inhabitants, and the distance of the settlement from

the city center gained importance only with the construction of modern transport infrastructure, which created more favorable conditions for the gradual migration of the population of remote peripheral settlements (Lović Obradović, 2019). The population dynamics of the settlements of the town of Smederevo can be interpreted in the same way, with transport links to the urban settlement becoming increasingly important over time. Thus, according to Lović Obradović (2019), the average distance of settlements from the city center in the group of developed municipalities and towns where the number of inhabitants decreased in the interim census period 2011/2002 was 16 km, and the average distance of settlements where the number of inhabitants remained the same in the same period increased and amounted to 14.3 km. The result we reached in the previous analysis, notwithstanding the fact that the majority of settlements (24/27) experienced a decrease in population, similarly separates the area of positive influence of the city center at a distance of 12 km when it comes to natural growth and 14 km when it comes to migration.

In a more detailed analysis of the relationship between geographical factors and demographic trends, it was shown that the different geographical factors change the population dynamics, but since the area of the City of Smederevo is characterized by a fairly geographical uniformity, the distance and transport connections are imposed as dominant geographical factors of differentiation of population dynamics between settlements. Settlements in relative proximity to the city center (and the center of economic activity) and settlements with a favorable transport and geographical location to the city center show a more favorable development of natural increase and net migration. On the other hand, the settlements of Binovac, Kulič and Šalinac are characterized by a high degree of negative demographic trends despite their short distance from the city center and good transport connections. In a way, the settlements mentioned can be considered peripheral, as they are not characterized by traffic permeability or functional integration into the urban/municipal system. In colloquial language, such settlements are referred to as "dead ends".

Although various studies have found regularities in the strength of the polarizing effect of urban settlements on the development of the environment (Tošić & Krunić, 2007; Živanović, 2016), there is still a lack of research on the consequences of the polarizing effect of the city on the components of the demographic dynamics of the surrounding settlements. The results we have obtained using the example of the settlements of the City of Smederevo clearly confirm the positive effect of proximity to the city center on the demographic development of the surrounding settlements. Although it is known that the spatial range of the gravitational effect of the city on the surrounding area is proportional to the strength of its influence, this fact must be "supplemented" by the importance of transport transitivity for the demographic development of the settlement, and not only by the simple distance

from the city center. The exceptions in the observed example are settlements with certain characteristics of the periphery, although they are located within the identified distance zone below 12 km, i.e. below 14 km when it comes to the values of natural growth rate and net migration.

Although the urban settlement of Smederevo plays the role of the center of urban agglomeration, the pole of concentration of population and economic activities, under whose direct and indirect influences the demographic, functional, socio-economic and physiognomic transformation of the surrounding settlements takes place (Tošić and Obradović, 2003), the aforementioned influences do not show linear spatial patterns when it comes to the demographic development of the settlements. The pursuit of uniform demographic development of the settlement raises the question of at what point of its growth the city center begins to violate the threshold of demographic sustainability of the settlement system within its functional area, i.e. how far does the reach of its influence extend (Vojković, Živanović & Magdalenić, 2018). To what extent does it contribute to the demographic vitality of its administrative area? Although the scope of analysis in this article is limited only to the area of the city of Smederevo, it is certain that the positive influences of the urban settlement of Smederevo extend beyond its administrative area, just as they do not reach all parts of the City area. The strength of the "positive demographic influence" of the urban settlement of Smederevo is significantly lower than the entire urban area, it decreases over time and is strongly dependent on the transport accessibility and permeability of the observed settlements. Roughly speaking, the area of positive demographic influence of the urban settlement coincides with the area of the Danube villages, while the Šumadija villages and then the Pomoravlje villages (due to better transport connections and permeability) remain outside this influence.

Since the urban area is divided into three larger natural geographic units (the Danube belt, the Pomoravlje belt and the Šumadija beam), it is possible to distinguish the settlements of the City of Smederevo in almost the same way when it comes to the change in natural growth and migration, with the highway corridor, with some deviations, representing the "magic border" of separation. The exceptions mentioned refer to the villages of Kulič, Šalinac, Lipe, Vranovo and Mala Krsna. Their deviation from the regularity can be explained by the fact that all five villages are located on the left bank of Velika Morava, while Kulič, Šalinac and Lipe are characterized by a certain peripheral location despite their proximity to the city center. Kulič and Šalinac objectively show a more negative demographic development than the group of settlements to which they belong (up to 13 km away). On the other hand, the villages of Vranovo and Mala Krsna, although classified as Pomoravlje villages, are characterized by their proximity to the center of the city's economic activities (Železara), as well as a special traffic transitivity towards the Braničevska region

(Požarevac) and the "Constantinople Road" (towards Velika Plana, Svilajnac, Kragujevac and Jagodina), which partly contributes to the demographic and general "vitality" of these settlements.

The problem of marginalization is noticeable at all regional levels, not only in the border areas, considering the relationship between the urban/municipal center and the periphery, where a large number of settlements that are far from the central places "remain "forgotten in space and time" and are not integrated into the urban/municipal systems. This is the situation in almost all Serbian municipalities, especially those outside the main transportation and development corridors (Vojković, Živanović, Magdalenić, 2018). In terms of demographic development, this case can be observed in the spatially distant, but also in the socio-economically and transport-marginalized settlements of the City of Smederevo. In the last interim census period, in our example, these are all villages along the Constantinople road from Skobalj to Saraorci and all Šumadija villages south and southwest of the highway. It is very surprising that Radinac, which represents a unique urban fabric with an urban settlement, has recently joined this group of settlements characterized by a significant population decline of over 12‰ per year. A significant part of the explanation lies in the fact that Radinac recorded a negative annual migration balance of over -10‰ in the period 2011-2022. The negative migration balance of this settlement even accounted for 1/3 of the total migration balance of all rural settlements in the urban area. It is obvious that the unfavorable circumstances related to the work and air pollution of the steel mill have triggered a significant wave of emigration from this settlement since 2012. Regardless of this exception, Figure 7 shows the distribution of settlements according to the values of the natural increase rate and net migration in the period 2011-2022, where it can be observed that no less than I4 settlements show a decline above the average (11.8‰), of which 12 belong to type I4 and the remaining two to type E4. The mentioned 14 settlements are on average 16.9 km away from the city center (17.8 km without Radinac), and all of them except Radinac (black square in the graph) are located at a distance of 13 or more kilometers, which is classified as "critical".
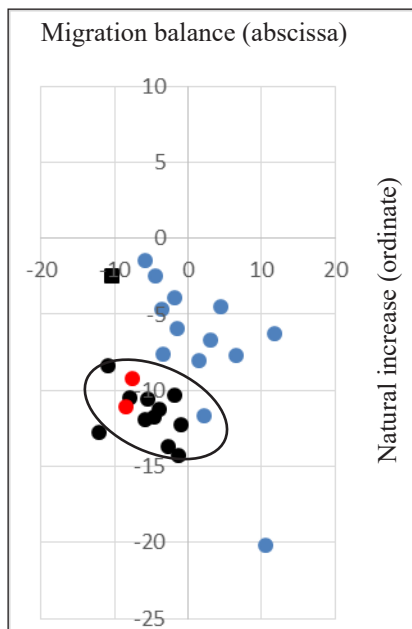
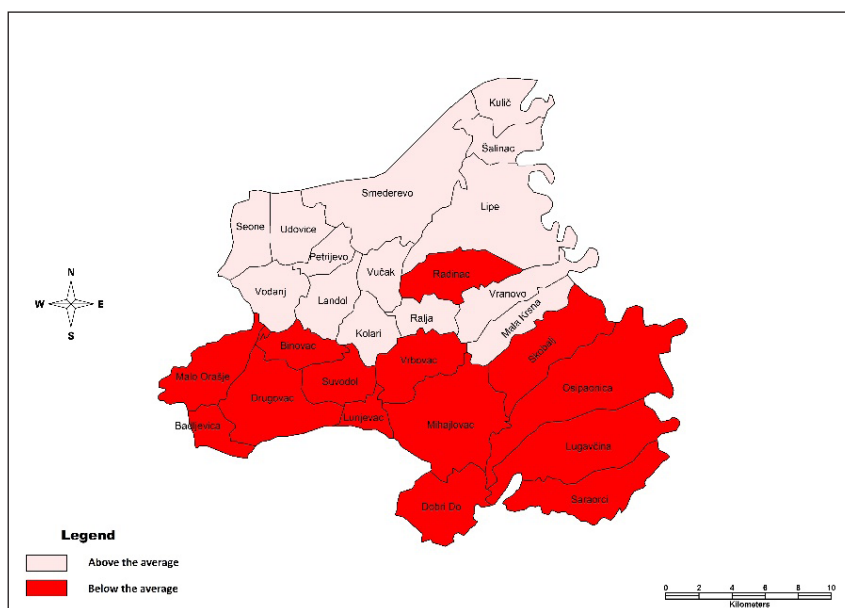*Figure 7. Natural and migration component 2011-2022 (annual rates)*

Figure 8. Annual population change rate related to the average value for the observed settlements (without city of Smederevo) 2011-2022

Although the relationship between natural growth and migration on the one hand and distance on the other have the same sign, i.e. the negative values of natural growth and migration increase with distance from the city center, the trends of these dependencies are completely opposite. The significance of distance for the level of the natural growth rate increases over time, while the significance of distance for the level of the migration rate decreases. From 1991 to 2022 (three survey periods), the value of the natural growth rate fell by 1‰ per 3.7 km distance in the first, 2.6 km in the second and 2.2 km in the third survey period. At the same time, net migration decreased by 1‰ per 1.1 km in the first, 1.3 km in the second and 2.8 km in the third census period.

It is interesting to note that the settlements of Osipaonica and Drugovac (red dots in Figure 7, which Tošić and Obradović (2003) recognized as potential micro-development cores, today, 20 years later, show one of the most intense demographic declines, ranking second and sixth, respectively, among the 27 rural settlements in the town of Smederevo. The question arises as to whether this "demographic fate" of part of the settlements of Smederevo could have been prevented or at least mitigated by a timely planning upgrade that would have promoted the functional transformation of the predominantly agricultural rural settlements with the establishment of light industry and service activities, which, together with the improvement of transport links (public and private transport), would have encouraged daily migration rather than out-migration?

Conclusion

Geographical theory and practice know and confirm the negative relationship between the spatial distribution of population and population dynamics on the one hand and the distance of urban settlements on the other. The contribution of this text to a more precise understanding of this relationship lies in the identification of spatial patterns in the movement of natural growth and net migration using the example of the settlements of the City of Smederevo. The importance of spatial distance for the components of population growth as well as socio-economic peripherality and "extrinsic" transport location, which cannot be neutralized by mere proximity to the city center, was confirmed. The positive "demographic influence" of the urban settlement of Smederevo on the surrounding settlements is significantly lower than its administrative area and continues to weaken over time. On the other hand, the disturbed age structure (which has a dominant influence on the natural growth rate) increasingly affects the growing importance of distance from the city center on the natural growth rate, while the reduced migration potential causes the decrease in the importance of distance on the net migration rate. In other words, the long-term

depopulation of the more distant settlements (naturally and through out-migration) led to a high concentration of population in the Danube area of the City.

The uneven (and often opposite) socio-economic development acted as a catalyst for negative demographic trends in more distant settlements, some of which were not integrated into the functional system of the city, forgotten and left to their fate. However, the City of Smederevo as a whole is characterized by less favorable socio-economic trends compared to other medium-sized cities in Serbia with a similar level of development (Antonić, 2022). Of the 24 medium-sized cities to which it belongs, the City of Smederevo ranked sixth in 2019 in terms of average salary (3% below the national average), eighth in terms of per capita investment (twice the national average) and twelfth in terms of per capita household inflow (19% below the national average).

Further neglect of the importance of the spatial dimension in the formulation of local public policy, especially population policy, will lead to demographic polarization of the Smederevo city area towards the more developed Danube coastal zone and the underdeveloped and demographically devastated hinterland of Pomoravlje and Šumadija. Regardless of the spatial-demographic differences, however, some of the most important causes of problems in the demographic development of Smederevo in the future will certainly be the weak diversification of the secondary and higher sectors of economic activity with a dominant link to a single factory and the lack of higher education institutions. There are 42 higher education institutions in the above-mentioned 24 medium-sized towns, and Smederevo is the only town apart from Loznica that does not have a single higher education institution. The predominant supply of low-skilled jobs in the ferrous metallurgy and heavy industry sectors and the lack of higher education institutions must guarantee high youth emigration rates, a further decline in the optimal birth rate and a shortfall in human capital in the future. In this sense, even a locally specific demographic policy could bring hardly any tangible results.

Acknowledgements

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