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ORIGINAL SCIENTIFIC PAPER

Evaluation of Population Projections for Serbia 2011-2041 after the 2022 Census Results

Dragana Paunović Radulović[1]* | **Marko Vladisavljević[2]**

[1] The University of Belgrade, Faculty of Economics, Department for Statistics and Mathematics, Belgrade, Serbia
Statistical Office of the Republic of Serbia
[2] The University of Belgrade, Faculty of Economics, Department for Statistics and Mathematics, Belgrade, Serbia

ABSTRACT
Following the 2022 Population Census, the first assessment of Serbia's official population projections based on data from the 2011 Census and other vital statistics and migration sources has become feasible. According to the Census results, the population of Serbia in 2022 is approximately 2.3% below the projected values for that year, according to the closest projection variant – the constant variant. This paper explores the differences in terms of projected and realized values of fertility, mortality, and migration balance. Hypotheses regarding the total fertility rate and the number of live births were largely confirmed. However, a notable deviation was observed in mortality rates, primarily attributed to the COVID-19 pandemic period, during which life expectancy decreased by nearly two years. Apart from the pandemic's effect, the deviation between projected and realized population values is also due to the assumption of a positive migration balance for the period 2011-2022. Contrary to this optimistic assumption, the vital statistics method reveals negative external migration during this period.

Keywords: *demographic projections, population census, components of demographic changes*

JEL Classification: C13, J10, J11, J13

INTRODUCTION

The study of population, particularly its size and optimal growth, has captivated scholars in the social sciences since ancient civilizations (Devedžić, 2006). Planning for the future dimensions of the population, including its total number and demographic composition, is imperative due to its fundamental impact on society (Nikitović, 2010). Population projections represent calculations of future demographic trends based on hypotheses - assumptions that depict potential outcomes influenced by anticipated changes in fertility, mortality, and migration patterns (CDI-IDN, 1971; Kicošev Golubović, 2004; Radivojević, 2018).

Creating demographic projections requires knowledge of long-term fertility, mortality and migration trends and all factors that influence population changes. This includes a good understanding of natural population movement and societal changes, i.e., the interdependence of demographic and social development (Rančić, 1979). For authors of hypotheses about future population trends, it is crucial to correctly assess the essence of current demographic trends, whether they are short-term changes, continuations, or beginnings of long-term trends (Penev,

* Corresponding author, dragana.paunovic-radulovic@stat.gov.rs

2013). On a local level, demographic projections are essential for all areas of human activity that involve planning, such as employment, education, healthcare, social security, spatial and urban planning, and more (Radivojević, 2018). Therefore, it is important that the projections are based on the most accurate assumptions about future trends in fertility, mortality and migration.

In the Republic of Serbia, official population projections are made every ten years – after each population census. In 2014, the Statistical Office of the Republic of Serbia (SORS) published the latest demographic projection results, covering the projection period 2011-2041. An analytical method was applied using a decomposition approach, which means that hypotheses were set for regions, and the projected population of Serbia represents the sum of the population projections of its constituent parts. Projections were made as a result of five defined scenarios that represent a combination of different levels of fertility, mortality and migration.

The subject of this paper is the evaluation of real and reconstructed values of the demographic components in the first ten years of the projection period and the decomposition of the difference between the projected population and population from Census 2022. Projected births, deaths, and net migrations were reconstructed based on existing documentation. The paper will present the projection methodology, the evaluation method, and the results of the analysis conducted. Since projections are not predictions but rather attempts to create credible scenarios based on assumptions regarding population growth components, the evaluation does not criticize the projection methodology. It serves as the first step in analyzing the factors that led to deviations from long-term trends. Projections are also subject to uncertainty, so it cannot be claimed that the projected values will always remain within the range of low and high growth scenarios. Unforeseeable circumstances occur, such as the COVID-19 pandemic, which caused "excess mortality" and influenced changes in migration trends (Marinković & Galjak, 2021). Therefore, the goal of this research is to highlight the problems and challenges in the mentioned process, while also showcasing examples of good practice in overcoming them, by evaluating the projection creation process and scenario definition processes.

THEORETICAL BACKGROUND

Population Projections in Serbia - Methodological Concept

Official population projections for the Republic of Serbia are prepared by the Statistical Office of the Republic of Serbia (SORS) after each population census. The latest results of demographic projections were published after the 2011 Census. These are long-term projections covering a period of 30 years (from 2011 to 2041). When creating population projections, an analytical method (cohort-component method) was applied, using the so-called decomposition approach. The analytical method of demographic projections implies that the hypotheses refer to future changes in the determining components of the population movement, i.e. fertility, mortality and migration, by age and gender. Due to the acceptance of the decomposition approach, hypotheses were set for regions (Belgrade region, Vojvodina region, Šumadija and Western Serbia region and Southern and Eastern Serbia region)[1], so the projected population of Serbia represents the sum of the population projections of its constituent parts, rather than the result of specifically set hypotheses (SORS, 2014, p. 8).

The projections were made in five variants: low, medium, high, constant fertility and mortality and zero migration balance variant (SORS, 2014, p. 8). Defining multiple variants of hypotheses results in different projection scenarios, named after the fertility hypotheses. Variants illustrate alternative scenarios of future demographic behavior, similar to projection methodology applied

[1] Given that the Census of Population, Households and Dwellings in 2011 was not conducted on the territory of AP Kosovo and Metohija, population projections were made for the Republic of Serbia without AP Kosovo and Metohija

by all relevant institutions in Europe and worldwide (e.g. Eurostat, UN Department of Population Statistics, national statistics).

The first three projection variants have the same combination of hypotheses about expected mortality and expected migrations and differ from each other only in fertility hypotheses. The fourth variant is based on the assumed constant fertility and mortality and expected migrations. The fifth variant, compared to the medium variant, differs only in terms of the migration hypothesis - this time a zero net migration was assumed. The last two variants have an analytical character, not a prognostic one (SORS, 2014, p. 8). The selection of scenarios was based on empirical data from vital statistics on total fertility rates and expected life expectancy in the previous period and theoretical knowledge about the factors of changes in all three population development components. Migration data are available from SORS research on internal migrations (data from the Ministry of Interior of RS on notification of change of address), and external migration is the result of the population difference between two censuses, adjusted for natural increase.

Although different variants for the other two components (mortality and migration) are assumed for the future age structure of the population, the most important thing is to define the future fertility trends. Biological determinants of reproduction (e.g., potential fertility, life span) change only over very long periods (Breznik, 1977, p. 56). The greatest uncertainty in population forecasts is usually associated with cohorts not born in the base (initial) year. Therefore, estimates of the number of children in the population are usually the most uncertain part of any medium-term forecast. Moreover, the margin of error significantly increases in long-term forecasts because their results increasingly depend on the accuracy of predicting births by women who have not yet been born.

Assumptions about Future Trends of Demographic Components

Fertility Hypotheses

Assumptions about the future movement of fertility were defined through the value of the total fertility rate[2] (TFR) by region (Table 1). In the base year, fertility is at the level of realized values in 2011, while the assumptions for the last projection year are given in four variants: low, medium, high and constant. Other values of TFR, in the 2011-2041 interval, represent the result of linear interpolation between the initial and final set values. In the fertility hypotheses, age-specific fertility rates, representing the distribution of births by mother's age, were also assumed. These assumptions are not presented with the presentation of the official results, but are stated to be modeled after the current values of specific rates at the beginning of the projection period.

Table 1. Hypothesis on the values of total fertility rate by variants and regions

Region	2011	2041			
		Low	Medium	High	Constant
Belgrade region	1.41	1.30	1.80	2.16	1.41
Vojvodina region	1.35	1.30	1.75	2.16	1.35
Šumadija and Western Serbia region	1.36	1.20	1.75	2.11	1.36
Southern and Eastern Serbia region	1.33	1.20	1.65	2.11	1.33

Source: Population projections of the Republic of Serbia 2011-2041, SORS, 2014, p. 9

[2] The total fertility rate represents the total number of live births per woman under fertility conditions by age from the year of observation.

Variations in assumed TFR are consistent with the spectrum of realistically achievable fertility levels within the European context. For instance, some European countries, such as Hungary, Romania, and Latvia, recorded a TFR of approximately 1.3 children per woman around 2010. Even lower levels, reaching as low as 1.1 children per woman, were observed in a broader range of countries during the 1990s and the early 2000s. These trends notably affected former socialist nations like Bulgaria, Czech Republic, Slovakia, Poland, Slovenia, Latvia, Lithuania, Russia, Ukraine, Belarus, and Moldova, as well as southern European countries such as Greece, Italy, and Spain. Conversely, Western European and Scandinavian countries generally achieved or exceeded a maximum assumed fertility level of 1.8 children per woman around 2010. Many of these countries had already reached this level during the 1990s and 2000s. Notably, Serbia also achieved this fertility level during the 1980s (Penev, 2013).

Mortality Hypotheses

Assumptions regarding future mortality trends were outlined in two scenarios: constant and variable, based on life expectancy values. Initial mortality data from approximate mortality tables[3] for 2011 served as the starting point for projections. Under the constant scenario, it was assumed that these rates would persist unchanged throughout the projection period. In contrast, the variable scenario posited mortality trends akin to those observed in Serbia in the decade leading up to the 2011 Census, aligning with broader trends in life expectancy across former socialist countries. Projections for 2041 incorporated an anticipated increase in average life expectancy across all age groups, based on empirical evidence. Consequently, the projection envisages a continuous linear decline in population mortality until the end of the forecast period (Table 2) (SORS 2014, p. 10).

Table 2. Life expectancy at live birth (variant of „expected“ mortality)

Region	**Sex**	**Beginning and end of the projected period**	
		2011	**2041**
Belgrade region	male	72.7	79.1
	female	77.8	82.2
Vojvodina region	male	70.5	76.2
	female	76.3	81.7
Šumadija and Western Serbia region	male	72.1	79.5
	female	76.9	84.0
Southern and Eastern Serbia region	male	71.4	76.3
	female	76.5	81.9

Source: Population projections of the Republic of Serbia 2011-2041, SORS, 2014, p. 10

The lowest value of life expectancy was recorded in Vojvodina in 2011, and the highest in Belgrade, for both sexes. Regional differences are expected to decrease by the end of the projection period, that is, life expectancy in Vojvodina and the Southern and Eastern Serbia region will equalize, and the longest life expectancy is predicted for the Šumadija and Western Serbia region: 79.5 years for men and 84.0 years for women (SORS, 2014, p.11).

[3] Mortality tables statistically show the relationships that exist between mortality, age and sex. They are calculated based on population estimates and vital statistics data. Life expectancy is the result of mortality tables that show how long a person of a certain age (0, 1, 5,..., 85 and more years) will live on average if the mortality conditions exist as at the time the tables were created.

Migration Hypotheses

Assumptions about future migration trends were formulated based on comprehensive statistical data, including the results of the last two Censuses in 2002 and 2011, internal migration statistics, natural population movement data, and information on registered internally displaced persons from Kosovo and Metohija. Hypotheses about migration are expressed through net migration and specific migration balance rates, by gender and age groups, at the regional level. (SORS, 2014, p. 11).

Assumptions about migration in the first and last five years of the projection period, by region, are presented in Table 3.

Table 3. Annual migration balance by region (variant of "expected" migration)

	Period	
	2011-2016	**2036-2041**
Belgrade region	9 692	14 867
Vojvodina region	-3 193	6 088
Šumadija and Western Serbia region	-3 540	10 127
Southern and Eastern Serbia region	-2 445	1 867
REPUBLIC OF SERBIA	514	32 949

Source: Population projections of the Republic of Serbia 2011-2041, SORS, 2014, p.11

According to the assumptions, under the expected migration scenario, the initial positive net migration in Belgrade offsets negative net migration in other regions, resulting in an overall net immigration of approximately 500 persons for Serbia. This assumption is grounded in anticipated improvements in living standards and economic recovery by 2026, with the expectation that the Republic of Serbia will accede to the European Union. The migration trends projected for 2014 draw insights from the experiences of countries like the Czech Republic, Hungary, and Slovakia, which transitioned to net immigration in the early 21st century. Additionally, given Serbia's aging population, the projections suggest a diminishing potential for emigration (Penev, 2013).

In addition to Serbia's ongoing population aging and the various demographic and economic implications that accompany this trend (a significantly aging population typically reduces emigration potential), the assumption was made that by the end of the projection period, Serbia will transform into an immigration destination (SORS, 2014, 12).

As an analytical variant, one projection scenario includes the hypothesis of a zero migration balance in the entire projection period. This implies that population changes are solely influenced by natural growth, specifically fertility and mortality rates.

Evaluation of Demographic Projections of National Statistics

In the existing literature, several methods have been developed for creating population projections, accompanied by various approaches to evaluating their accuracy. For decades, the United Nations' population projections for all countries have been scrutinized in scientific research. Pflaumer (1993) emphasizes the importance of quantifying the precision of demographic projections through error measurement. This study aims to improve future projections by assessing deviations in predicted population growth rates compared to actual rates published in multiple editions of the UN Demographic Yearbook. The results indicate overall satisfactory forecasting performance across most countries. However, notable forecast errors were observed primarily in African nations, where population growth was consistently underestimated.

In addition to evaluating the accuracy of specific methods for population projections, research also aims to identify the most effective techniques for forecasting. For instance, Morgenroth (2002) conducted a study assessing the performance of different demographic forecasting methods in Ireland. The study analyzed forecast errors of each method from 1991 to 1996, comparing projected populations with the 1996 census data. Interestingly, the results indicate that simple proportion extrapolation techniques often outperform the more complex cohort component models typically used for national projections.

George (2001) emphasizes several critical steps in the evaluation of population projections. Firstly, it's essential to select the scenario—whether medium, high, low, or all scenarios—to be evaluated. Secondly, choosing the appropriate evaluation method is crucial. Thirdly, identifying the specific demographic variable or component—such as fertility, mortality, migration, or age groups—that requires assessment is important. In his analysis of Canadian population projections before 1972, George evaluates their accuracy retrospectively in terms of population size, age structure, and growth components. The findings reveal significant variability in errors across different age groups, with projections published later generally proving more accurate than earlier ones. The inaccuracies in earlier projections are attributed to several factors. These include the failure to anticipate the postwar baby boom, underestimated fertility assumptions during the 1940s, and overestimations during the subsequent fertility decline starting from 1959. George argues that projection inaccuracies are inevitable due to uncertainties in future trends. To manage this uncertainty, he suggests publishing multiple scenarios that encompass a range of possible growth component trends. This approach allows for a more comprehensive understanding of potential future population dynamics.

In the work of researchers who evaluated the population projections of Norway between 1996 and 2018 (Thomas et al., 2022), most analyses are based on simple comparisons of projected and registered population components. The results of the evaluation indicate that the expected life expectancy was consistently lower than the actual life expectancy. Several systematic deviations in fertility were observed until 2009, but thereafter fertility was consistently overestimated. Significantly larger deviations were observed for net international migration. Projections produced between 1996–2005 underestimated long-term population growth primarily due to an unanticipated increase in immigration after EU enlargement in 2004. More recent projections do not consistently underestimate or overestimate net migration, and deviations for the total population are moderate.

DATA AND METHODOLOGY

Data Sources

Following the release of the final results of the 2022 Census, an evaluation of demographic projections becomes possible. This assessment will compare the projected figures with the actual demographic data recorded in the census, examining deviations in assumptions regarding fertility, mortality, and migration trends. Alongside the population census results, officially published data on fertility and mortality during the inter-census period were used in the evaluation of hypotheses. In the absence of official research on external migration in Serbia, the migration balance for the Republic of Serbia used for hypothesis evaluation is the result of vital statistics methods.

Methodology for the Evaluation of the Hypothesis of Projections of the Serbian Population 2011-2041

In 2014 projections, assumptions regarding future demographic trends are primarily derived from historical trends of TFR and life expectancy. Migration projections, on the other hand, rely on alternative data sources for analysis. However, official publications do not provide exact projected figures for live births and deaths. To address this gap, a reconstruction of these series was conducted using available vital statistics and demographic indicators published by the Statistical Office of the Republic of Serbia (SORS).[4]

The reconstruction involved interpreting the hypothesis of change in demographic components based on available data. This approach acknowledges potential deviations from actual values in the projections. Specifically, to estimate projected live births, a model incorporated age-specific fertility rates from 2011 and the number of women of childbearing age, alongside assumptions about TFR. The resulting estimates were then compared with actual vital statistics data on live births.

Regarding migration, projected net migration values were reconstructed using official publication data. For the initial five years of projections (2011-2016), the migration balance level was set at 514 based on official data, with subsequent years interpolated linearly between this value and the value for the final projection period (2036-2041). However, it's important to note the lack of an official source for monitoring migration, there is no official number of emigrants and immigrants of Serbia, on the basis of which the migration hypothesis could be evaluated. For this purpose, the total external migration was calculated based on the vital statistics method:

$$S = P_2 - P_1 - (N - M) \quad (1)$$

where: S is the net migration; P_1 and P_2 are numbers of inhabitants according to the results of the 2011 and 2022 Census, respectively[5]; N is the number of live births and M is the number of deaths in the inter-census period, based on vital statistics.

Finally, the estimation of projected deaths is based on the basic demographic equation (Radivojević, 2018). This equation utilizes projected values of population size over successive years, along with live births and migration balances reconstructed according to previously described assumptions. The projected number of deaths is thus residual population change after accounting for live births and migration. The projected number of deaths derived from this method was then compared against official vital statistics data. Reconstructed projected number of deaths could have been refined using inverse biometric functions based on assumed age-specific mortality rates or by incorporating data on person-years lived between exact ages x and x+1 (denoted usually as Lx in Life tables), which are essential for calculating survival rates. Such data would have facilitated a more precise reconstruction of death numbers by aligning them with assumptions about life expectancy at birth and age-specific Lx values. However, this level of detail was not available in the population projection method and results, primarily because the software used relies on pre-set mortality patterns deemed most representative for different regions (such as European countries, African regions, etc.).

It is important to note that the methodology used for reconstructing projected values of live births, deaths, and migration balances may not precisely match the actual values used in the projections. Discrepancies arise due to the use of available documentation and the reliance on the Spectrum application software for the population projections from 2011 to 2041. As already

[4] Demographic statistics, Press release (RZS, 2019; RZS, 2021; RZS, 2022)

[5] It is important to note that different values of the number of inhabitants for 2011 can be found in the publications of the SORS. These are estimates made based on the 2002 and 2011 Censuses, and after an expert assessment of the number of inhabitants for Bujanovac, Medveđa and Preševo, at the critical moment of the 2011 Census, the estimates were subsequently revised. All these changes in the total number of inhabitants refer to differences in the structure by age, which can affect the differences in the value of derived demographic indicators, specific fertility and mortality rates. Projections were made immediately before the publication of the latest data on population estimates for 2011, which are still relevant as official data.

mentioned, this software incorporates a model of mortality tables that can yield results differing from those presented in this study.

The evaluation of official population projection results was conducted at the regional level, with assumptions regarding the expected future trends in fertility, mortality, and migration (the medium variant of population projections). This paper focuses on presenting key national-level findings from the analysis. Throughout this paper, all comparisons between projected and realized demographic component values pertain to aggregate numbers of live births, deaths, and migration balances, without gender or age-specific analysis.

RESULTS AND DISCUSSION

Results of the 2022 Census and the Difference Compared to the Projected Population

According to the final results of the 2022 Population Census, the Republic of Serbia has a population of 6 647 003 inhabitants. This figure reflects a decrease of 539 859 people, or 7.5%, compared to the 2011 Census. The population declined across all regions by approximately 10%, except in the Belgrade region, where there was a modest increase of about 1.3% (Table 4). It is important to note that during the 2011 Census, the municipalities of Bujanovac, Preševo, and Medveđa experienced a significant undercount of approximately 46 800 individuals due to a boycott by the Albanian ethnic population. Adjusting for this, an estimated total of 7 233 619 people can be considered for 2011, revealing a larger decrease of 586 616 inhabitants. Additionally, the total population reported in the 2022 Census includes both enumerated individuals and adjustments from administrative sources for those not initially counted, a practice not applied in previous censuses (RZS, 2023).

Table 4. Population according to 2022 and 2011 censuses, by regions

	Number of inhabitants		**Absolute growth/fall**	**Change index**
	2011 Census[6]	**2022 Census**	**2022-2011**	**2011=100**
REPUBLIC OF SERBIA	7 186 862	6 647 003	-539 859	92.5
Belgrade region	1 659 440	1 681 405	21 965	101.3
Vojvodina region	1 931 809	1 740 230	-191 579	90.1
Šumadija and Western Serbia region	2 031 697	1 819 318	-212 379	89.5
Southern and Eastern Serbia region	1 563 916	1 406 050	-157 866	89.9

Source: Author's calculations based on SORS data.

Table 5 indicates that all projection variants anticipate a higher population count than the one obtained in the census. In other words, all projection variants from 2014 overestimated the population figures for 2022. The constant variant shows the smallest deviation, overestimating the census count by about 2.3% (approximately 154 000 inhabitants). The low and no-migration variants exceed the census count by 3.2% and 3.4%, respectively, while the medium and high variants overestimate by 4.1% (around 284 000 inhabitants).

At the regional level, the constant variant also exhibits the closest alignment with the census population in 2022. Variations between the census and projections range from -2.5% to -1.7% across regions (Table 1 in the Appendix), indicating smaller discrepancies compared to other projection scenarios.

[6] An expert estimate of the population is available at the link http://www.kt.gov.rs/sr/news/arhiva-vesti/saopstenje-za-javnost-procenjen-broj-stanovnika-u-opstinama-presevo-bujanovac-i-medvedja/

Table 5 provides a comprehensive view of the differences between demographic projections and the 2022 Census results, allowing for a clear comparison and analysis of projection accuracy across different scenarios.

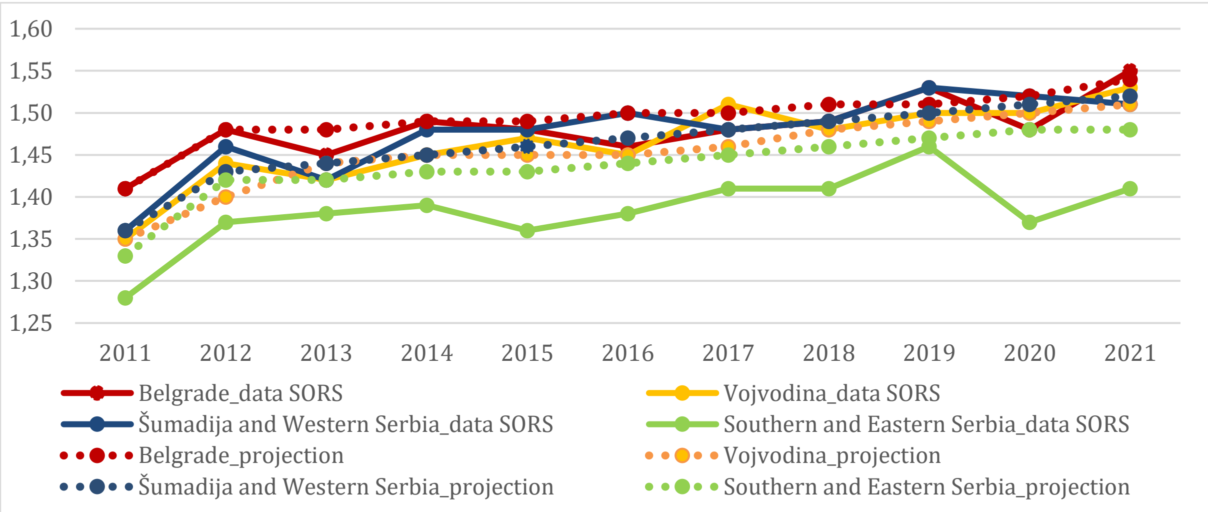
Table 5. Total population of Serbia in 2022, demographic projections and Census 2022

Projection scenario variants	Population number in 2022		Difference	
	Population projection	2022 Census	Absolute value	%
REPUBLIC OF SERBIA				
Low variant	6 869 483	6 647 003	-222 480	-3.2
Medium variant	6 930 363	6 647 003	-283 360	-4.1
High variant	6 930 768	6 647 003	-283 765	-4.1
Constant variant	6 800 950	6 647 003	-153 947	-2.3
Variant without migrations	6 884 005	6 647 003	-237 002	-3.4

Source: Author's calculations based on SORS data

Fertility Indicators - Comparison of Projected and Realized Values

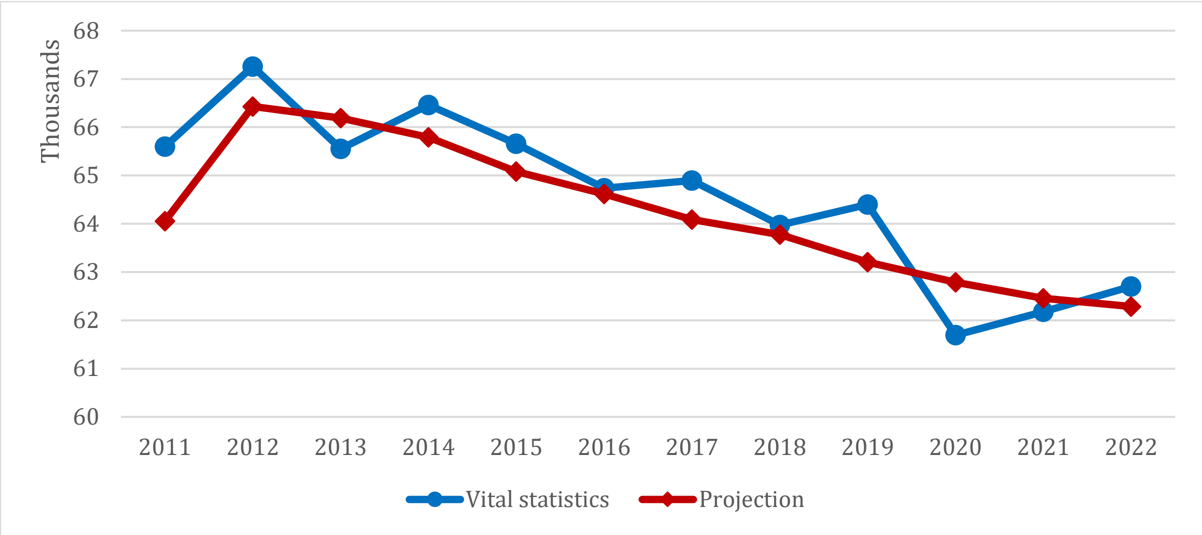
Comparing the projected and realized total fertility rates, in most cases, reveals insignificant deviations (Graph 1). This observation underscores the gradual nature of fertility rate changes, largely influenced by natural birth dynamics (Breznik, 1977). However, an exception is noted in the projections for the Southern and Eastern Serbia region, where the total fertility rate is slightly higher, reaching 1.5 in 2021, compared to the achieved fertility level of 1.4 children per woman. In essence, the projections slightly overestimated the actual fertility level. Graph 1 also illustrates that while deviations occurred throughout the projection period in this region, they were most pronounced during the years of the COVID-19 pandemic.



Graph 1. Projected (medium variant) and realized values of TFR

Source: SORS, author's processing

As previously noted, official publications do not provide data on projected live births. For this study, the number of live births was reconstructed using the Total Fertility Rate (TFR) obtained upon special request from the author of the official projections. Comparison of these reconstructed values with data from a survey on births spanning 2011-2022 (Graph 2) reveals minimal deviations between projected and realized fertility rates. On an annual basis, these deviations hover around ±2%, translating to approximately 300 live births relative to realized values. Notably, during the COVID-19 pandemic, it was anticipated that birth rates would decline compared to the periods immediately preceding and following the pandemic, thereby resulting in overestimations in projected live birth numbers for that timeframe (Penev, 2021).



Graph 2. Number of live births, 2011-2022

Source: Author's calculation based on SORS data

Migration of the Population - Comparison of Projected and Realized Values

The realized net migration was calculated using the vital statistics method (Table 6). This calculation indicates that external migration between September 30, 2011, and September 30, 2021 (key points coinciding with the 2011 and 2022 censuses), amounted to approximately -120 000 persons.

Table 6. Population migrations between two successive population censuses in 2011 and 2022

The result of the vital statistics method_total net migration of the Republic of Serbia	2011-2021
30 September 2011, value based on the 2011 Census	7 186 862
The value from the 2011 Census corrected for the municipalities of Preševo, Bujanovac and Medveđa	7 233 619
30 September 2022, value based on the 2022 Census	6 647 003
Difference	-586 616
Natural increase 30 September 2011 - 30 September 2022	-466 175
Migration balance (external migration) [7]	-120 442

Source: SORS, author's presentation

*Notes: [1]The total values of the changes were obtained by the formula 1/4*2011+ ∑(2012,2021) +3/4*2022*

[7] The more accurate value of the natural increase is -469 133 if the exact values of live births and deaths in the periods October-December 2011 and January-September 2022 are taken into account. The realized value of the migration balance then amounts to -117 483. However, in order to be consistent with the methodology applied in the estimation of the effects related to the projections, we use the method shown in Table 6.

Based on predefined migration patterns from 2011 to 2041, as detailed in Table 3, a reconstructed projection of net migration was employed for evaluation purposes. This reconstruction involved adopting specified values for the years 2011 to 2016 and applying linear interpolation at the regional level from 2016 to 2036. The annual migration values reconstructed for the period 2011 to 2022 are provided in Table 7. According to these reconstructed projections, it was anticipated that a net emigration of approximately 35 000 individuals would occur during the inter-census period (see Table 8 for the cumulative calculation during this period).

Table 7. Migration balance 2011-2022

	Republic of Serbia	**Belgrade region**	**Vojvodina region**	**Šumadija and Western Serbia region**	**Southern and Eastern Serbia region**
2011-2016	514	9 692	-3 193	-3 540	-2 445
2017	2 136	9 951	-2 729	-2 857	-2 229
2018	3 758	10 210	-2 265	-2 174	-2 013
2019	5 380	10 469	-1 801	-1 491	-1 797
2020	7 002	10 728	-1 337	-808	-1 581
2021	8 624	10 987	-873	-125	-1 365
2022	10 246	11 246	-409	558	-1 149

Source: SORS, authors' presentation

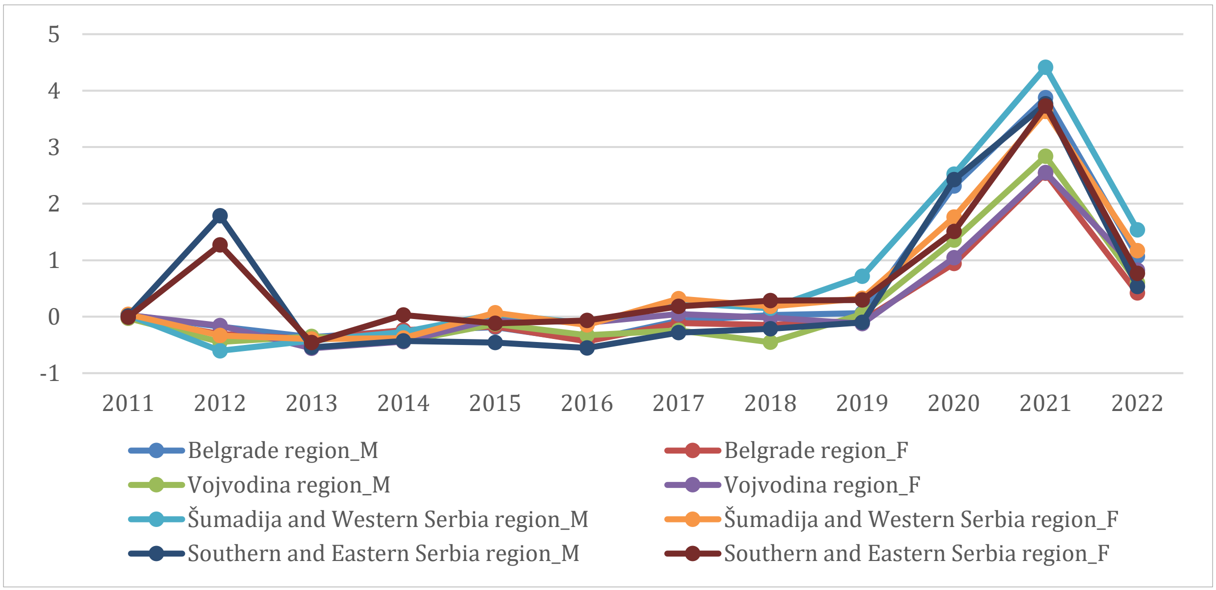
Note: The data presented are based on projected values for expected migrations.

The previous analysis, based on the hypotheses presented in the projections and evaluated using the vital statistics method, reveals that the assumption of positive net migration was incorrect in terms of both direction and intensity. The actual net migration was observed to be overestimated by approximately 155 000 inhabitants, as the projections assumed a net immigration of 35 000 inhabitants while a net emigration of 120 000 inhabitants was estimated via the vital statistics method. However, it's important to note that evaluating the migration component using the vital statistics method has its limitations. Net migration is calculated as a residual value based on differences in population counts between two censuses (which can vary due to methodological factors) and natural population change.

Mortality Indicators - Comparison of Projected and Realized Values

A comparison of projected and realized values of life expectancy indicates that the deviations between these values are not high until 2019 (Graph 3), which occurred due to the effects of the COVID-19 pandemic.

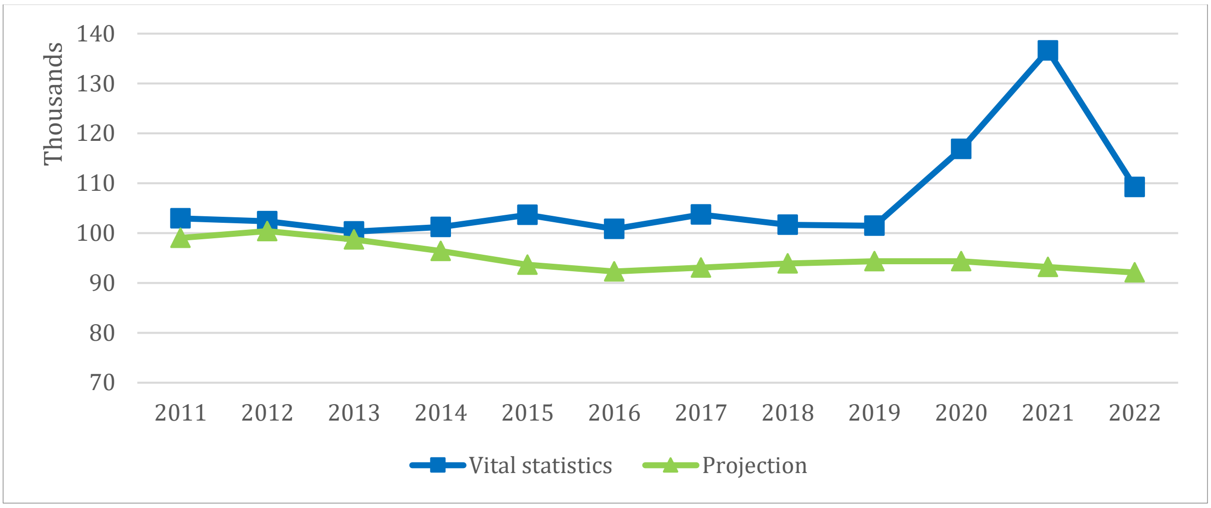
Considering that mortality assumptions are based on historical trends in life expectancy, it is important to assess whether deviations in the number of deaths have occurred, as these directly influence projections. As previously mentioned, official projection reports do not provide direct data on the number of deaths, making it impossible to reconstruct them directly from projections. Therefore, this study opted to estimate the number of deaths as a residual part of projected population growth each year, factoring in reconstructed projections of live births (as shown in Graph 2) and migration balances (Table 7).



Graph 3. The difference between the projected (medium variant) and realized values of life expectancy

Source: Author's calculation based on SORS data

The resulting estimated number of deaths is presented in Graph 4, alongside actual recorded values. The COVID-19 pandemic significantly impacted life expectancy, reducing it by nearly two years. Analysis of death statistics between the 2011 and 2022 censuses indicates that mortality rates during the pandemic years far surpassed pre-pandemic averages, resulting in approximately 50 000 excess deaths in 2020 and 2021 (UNDP, 2022), with an additional 8 000 excess deaths in 2022. Until 2019, prior to the onset of the COVID-19 pandemic, projected deaths were slightly lower than realized, with an average deviation of approximately 6% and a maximum deviation of around 10%. During this period, actual annual deaths exceeded projections by an average of about 6 300.



Graph 4. Number of deaths, 2011-2022.

Source: Author's calculation based on SORS data

Decomposition of the Difference between the Projected and Censused Population

Table 8 presents the series derived from the reconstruction of projected demographic components, alongside official vital statistics data and assessment of net migration using the vital statistics method. In this way, we disaggregate the total difference in population decline between the projected and realized numbers of inhabitants from the 2011 to 2022 censuses to its components. It's important to note that projected annual population values represent yearly averages, while census figures for 2011 and 2022 reflect counts at the critical census moment (September 30). Therefore, when summing realized values for census years, demographic component values were adjusted to one quarter or three quarters in 2011 and 2022, respectively. In contrast, projections, which are calculated for mid-year, use half-year values for census years.

Table 8. Demographic components and number of inhabitants according to the projections of Serbia

	Census and vital statistics				**Projected value - medium variant**			
Year	**Population number (Census)**	**Live births**	**Deaths**	**Migration**	**Population number (projection)**	**Live births**	**Deaths**	**Migration**
2011	7 233 619	65 598	102 935		7 234 099	64 052	99 049	514
2012		67 257	102 400		7 200 033	66 430	100 400	514
2013		65 554	100 300		7 167 188	66 188	98 687	514
2014		66 461	101 247		7 136 063	65 794	96 432	514
2015		65 657	103 678		7 106 941	65 083	93 666	514
2016		64 734	100 834		7 079 925	64 614	92 301	514
2017		64 894	103 722		7 052 596	64 084	93 059	2 136
2018		63 975	101 655		7 026 247	63 775	93 893	3 758
2019		64 399	101 458		6 999 877	63 207	94 383	5 380
2020		61 692	116 850		6 974 655	62 790	94 355	7 002
2021		62 180	136 622		6 950 752	62 459	93 230	8 624
2022	6 647 003	62 700	109 203		6 930 361	62 286	92 098	10 246
Change 2011-2022	-586 616	710 228[1]	1 176 402[1]	-120 442	-303 738	707 593[2]	1 045 977[2]	34 850[2]
					Deviations of projected and realized values in the observed period			
					-282 878	- 2 635	-130 425	-155 292

Source: SORS, presentation of additional authors' calculation

*Notes: [1]The total values of the changes were obtained by the formula 1/4*2011+ ∑ (2012,2021) +3/4*2022, because the critical moment of the census is 30 September. [2]The total values of the changes were obtained by the formula 1/2*2011+ ∑ (2012,2021) +1/2*2022 because the projected population refers to the middle of the year.*

Births, deaths, and migrations are aggregated for easier overall comparison of changes, considering the different time points referenced by various data sources. According to census data, Serbia's population decreased by 586 616 (adjusted the correction for municipalities of Bujanovac, Preševo, and Medveđa) from September 30, 2011, to September 30, 2022. Conversely, projections made in 2014 anticipated a population decline of 303 738 (annual average) during the same period. This results in a difference of 282 878 between realized and projected population decline figures.[8]

The projected number of births falls short by 2 635 compared to the official count. This discrepancy would have been even smaller if not for the effects of the COVID-19 pandemic, which slightly reduced fertility levels during that period. Thus, the set fertility rate values proved adequate, resulting in minor deviations in the number of live births.

As per projections, migrations were expected to contribute positively to population change, estimating a net immigration of approximately 35 000 individuals based on available data. However, the vital statistics method calculated a net migration of about -120 000 for the inter-census period from 2011 to 2022. This indicates that projections overestimated the potential for population growth from this component. Considering the divergent migration flows between projections and vital statistics results, migration accounts for a total contribution of approximately -155 000 to the difference between projected population decline and the actual decline observed between the 2011 and 2022 censuses.

It's important to note that external migration data scarcity makes this component the most challenging to estimate and forecast accurately. The only official document providing a comprehensive overview of migration statistics for the Republic of Serbia is the Migration Profile, published annually by the Commissariat for Refugees and Migration. It states that Serbian citizens who go abroad with the intention of staying for more than 90 days must register their extended stay with the relevant authorities through diplomatic or consular representatives. However, this is not the case in practice. Serbia, as an emigration country, lacks complete records of its emigrants; therefore, the Migration Profile relies on Eurostat data on the number of immigrants published by EU member states for the current year (KIRS, 2023).

Except for the mentioned document, there is no official estimate of the extent of migration movements outside of national borders. On the other hand, there are unofficial studies on migration estimates conducted for various analytical purposes. In 2019, the Statistical Office of the Republic of Serbia (SORS), with support from UNFPA, conducted a study aimed to investigate alternative data sources beyond those provided by the Ministry of Interior RS. Key data sources included Eurostat databases, national statistics, the population census, student records by nationality, and vital events based on the usual resident concept. Covering the period from 2011 to 2018, the study projected migration trends up to 2021 and assessed Serbia's total migration relative to each of the analyzed countries identified as the most frequent destinations for Serbian migrants, using the "mirror statistics" method (UNFPA, 2019).

It must be said that managing migration is a challenge from both a regional and global perspective. For example, national migration statistics in former Yugoslav countries, excluding Croatia and Slovenia, are often inaccurate, incomplete, or unavailable. In contrast, EU member states have a more systematic approach, collecting and submitting migration data to Eurostat based on Regulation 862/2007[9]. Generally, data sources used are diverse, encompassing statistical and administrative records, such as population registers and residence permits for reasons like education, family reunification, and work, as well as border crossing data, special surveys, and "big data" from digital devices and online platforms.

Having in mind the projected values for the number of births and migration balance, both of which were previously described, the discrepancy between the projected and actual number of

[8] The evaluation of each of the demographic components resulted in a total difference in the population decline according to projections and census results of about -288 000 persons. The difference of about 5 000 (about 1.7%) can be attributed to numerous factors such as: 1) the lack of exact projected values for demographic components, which were reconstructed based on the methodological solutions presented in this paper, and official demographic projections 2) the differences in the timing of the inter-census period (September 30, 2011 and 2022) and 3) methodological differences that exist between the two censuses.
[9] http://data.europa.eu/eli/reg/2007/862/oj

deaths during the inter-census period amounts to approximately 130 000 individuals. A significant portion of this difference, approximately 58 000 deaths, can be attributed to excess mortality resulting from the COVID-19 pandemic. The remaining overestimation in mortality amounts to about 72 000 individuals, translating to roughly 6 000 people annually (approximately 6% of the total number of deaths).

Graph 3 illustrates that the most substantial deviations in life expectancy occurred during the pandemic years, whereas there were no significant deviations in predicted versus realized life expectancy in the period preceding the pandemic. Hence, the lower-than-expected number of deaths is likely due to differences between the realized and projected age structures of the population. These differences can stem from various factors, partly influenced by migration assumptions. Specifically, the migration hypotheses assumed not only a positive migration balance but also a more favorable age structure for Serbia's population, resulting in slightly lower mortality rates.

Finally, in this research, the reproduced number of deaths was derived as an unknown value in the demographic equation, based on the population size (according to projections) for two consecutive years, and reconstructed projected births and net migration. Migration values were interpolated between the initial and final values of the projection interval.

CONCLUSION

According to the 2022 Census results, Serbia's population stood at 6 647 003, which is approximately 2.3% (about 154 000 inhabitants) lower than the projected values for that year under the closest variant of projections—the constant variant. The low variant and variant without changes in net migration overestimated the census result by 3.2% and 3.4%, respectively, while for the medium and high variants projected population figures for 2022 were 4.1% higher (about 284 000 inhabitants).

The overestimation in the projections during the first decade of the projection period can be partly attributed to "excess mortality" during the COVID-19 pandemic. However, the more significant deviation is due to the fact that negative net migration occurred, while positive net migration was projected. These circumstances were unforeseen at the time of making the demographic projections following the 2011 Census. However, considering the registered number of live births and deaths in 2022, and the rebound in life expectancy to pre-pandemic levels, we can view the COVID-19 pandemic as an external shock affecting long-term demographic trends.

The lack of research on external migration presents a specific challenge in predicting future migration flows. Similar assumptions regarding migration were also utilized in the national study "Population Projections of Serbia from 2010 to 2060," published by the Fiscal Council of the Republic of Serbia. Improvement in assumptions could be made based on diverse data sources, such as the number of enrolled foreign students, Ministry of Interior databases on foreigners, statistics on deregistrations and registrations of residence, "Mirror statistics" from Eurostat on migration flows, residence permits, national statistical data, UN recommendations, and ad-hoc research on external migration.

It's important to acknowledge the limitations of this study. The evaluation of population projections from 2014 was based on reproducing projected population figures for Serbia from 2011 to 2022 using available data. The relevance of this evaluation depends on the accuracy of the reproduced series. To enhance future assessments, greater transparency and availability of population projection data would facilitate more precise and comprehensive evaluations.

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APPENDIX

Table 1. Total population of Serbia in 2022, demographic projections and Census 2022

Projection scenario variants	Population number in 2022		Difference	
	Population projection	2022 Census	Absolute value	%
REPUBLIC OF SERBIA				
Low variant	6 869 483	6 647 003	-222 480	-3.2
Medium variant	6 930 363	6 647 003	-283 360	-4.1
High variant	6 930 768	6 647 003	-283 765	-4.1
Constant variant	6 800 950	6 647 003	-153 947	-2.3
Variant without migration	6 884 005	6 647 003	-237 002	-3.4
Belgrade region				
Low variant	1 748 270	1 681 405	-66 865	-3.8
Medium variant	1 750 042	1 681 405	-68 637	-3.9
High variant	1 750 059	1 681 405	-68 654	-3.9
Constant variant	1 722 572	1 681 405	-41 167	-2.4
Variant without migration	1 615 628	1 681 405	65 777	4.1
Vojvodina region				
Low variant	1 805 678	1 740 230	-65 448	-3.6
Medium variant	1 823 334	1 740 230	-83 104	-4.6
High variant	1 826 340	1 740 230	-86 110	-4.7
Constant variant	1 784 858	1 740 230	-44 628	-2.5
Variant without migration	1 846 499	1 740 230	-106 269	-5.8
Šumadija and Western Serbia region				
Low variant	1 875 111	1 819 318	-55 793	-3.0
Medium variant	1 898 216	1 819 318	-78 898	-4.2
High variant	1 896 768	1 819 318	-77 450	-4.1
Constant variant	1 850 789	1 819 318	-31 471	-1.7
Variant without migration	1 938 392	1 819 318	-119 074	-6.1
Southern and Eastern Serbia region				
Low variant	1 440 424	1 406 050	-34 374	-2.4
Medium variant	1 458 771	1 406 050	-52 721	-3.6
High variant	1 457 601	1 406 050	-51 551	-3.5
Constant variant	1 442 731	1 406 050	-36 681	-2.5
Variant without migration	1 483 486	1 406 050	-77 436	-5.2

Source: SORS, authors' calculation

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