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IDENTIFYING CHARACTERISTICS AND TYPOLOGY OF SMALL SHRINKING TOWNS IN SERBIA: THE CASE OF THE REGION OF SOUTHERN AND EASTERN SERBIA

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The Old Bazaar in Knjaževac, small shrinking town in eastern Serbia.

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Identifying characteristics and typology of small shrinking towns in Serbia: The case of the Region of Southern and Eastern Serbia

ABSTRACT: Small towns are highly exposed to urban shrinkage, but the attention to them has still been weak in the research, especially in Serbia. Therefore, this study deals with small towns in the Region of Southern and Eastern Serbia, with the goal of elaborating a typology of small towns based on shrinking characteristics. Shrinking small towns were first mapped and then grouped using principal component and cluster analysis. The results indicate that the patterns of shrinking differ and that four clusters of shrinking towns with distinguishable specific characteristics can be identified. This research contributes to understanding of different causes and trajectories of small shrinking towns and suggests a possible application of presented methodology as an urban planning tool.

KEYWORDS: urban shrinkage, small towns, cluster analysis, principal component analysis, Serbia

Ugotavljanje značilnosti in tipologije malih krčečih se mest v Srbiji: primer regije Južne in vzhodne Srbije

POVZETEK: Mala mesta so zelo izpostavljena krčenju, vendar se jim v raziskavah, zlasti v Srbiji, še vedno posveča premalo pozornosti. Zato v tej študiji obravnavamo majhna mesta v statistični regiji Južna in vzhodna Srbija s ciljem oblikovati tipologijo majhnih mest na podlagi značilnosti njihovega krčenja. Majhna mesta, ki se krčijo, smo najprej določili, nato pa združili v skupine z uporabo analize glavnih komponent in metod razvrščanja v skupine. Rezultati so pokazali, da se vzorci krčenja razlikujejo in da je mogoče opredeliti štiri tipe krčečih se mest s svojstvenimi značilnostmi. Pričujoča raziskava prispeva k razumevanju različnih vzrokov in usmeritev krčenja malih mest ter predlaga možnost uporabe predstavljene metodologije kot orodja za urbanistično načrtovanje.

KLJUČNE BESEDE: krčenje mest, mala mesta, razvrščanje v skupine, metoda glavnih komponent, Srbija

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1 Introduction

Shrinking cities have become global phenomenon and a common path of development of many cities since the second half of 20th century. This affected the growth of international research, as well as the development of international discourse about this phenomenon (Großmann et al. 2008; Fol and Cunningham-Sabot 2010; Haase et al. 2017; Mallach 2017). More extensive comparative surveys of shrinking cities give an overview of persistence and spatial extent of this phenomenon in the world (Oswalt and Rieniets 2006) or Europe (Turok and Mykhnenko 2007; Wiechmann and Wolff 2013) and they are based on dynamics of population loss. National context plays an important role in trajectories of urban shrinkage and its tipology, e.g., for United States (Beauregard 2009), France and UK (Cunningham-Sabot and Fol 2009) of Portugal (Alves et al. 2016). These typologies indicate the heterogeneity of the process of urban shrinkage in terms of intensity, dynamics and drivers, as well as the importance of researching this process at different spatial levels (national, regional and local).

Previous studies on shrinking cities have obtained abundant results, but the most of them focus on larger cities. However, the large portion of small towns in Europe has been shrinking (Schlappa and Neill 2013), especially in Central and Eastern Europe (CEE) (Leetmaaa et al. 2015; Ljubenović et al. 2022), where their development was additionally affected by post-socialist transformation. Small towns are mostly considered the losers of the globalization process (Fertner et al. 2015), not relevant to the system (Bernt and Rink 2010), or peripheral in relation to the decision-making process and institutional networks (Cox and Longlands 2016). Compared to larger cities they usually lack resources in the field of education, research and qualified jobs, and have insufficient territorial connectivity (Valtenbergs et al. 2015; Fol and Cunningham-Sabot 2010). In recent years, small towns have received much more research attention in Europe (e.g., Knox and Mayer 2009; Kwiatek-Sołtys and Mainet 2014; Filipović et al. 2016), but there is still a lack of research focusing on urban shrinkage.

In Serbia, the phenomen of shrinking cities has only recently been investigated, while various demographic and economic problems have been pronounced in many cities and towns (Bajić Brković 2010; Penev 2014). Depopulation of urban settlements in Serbia was first registered in the 1991–2002 intercensus period, to become more intensive in the early 21st century. Population loss was most pronounced in small towns, while larger cities stagnated or grew (Ljubenović et al. 2018). The results of the latest Census in 2022 (RZS 2023) indicate the decline in the total population of Serbia of about 7.5% compared to the 2011 Census. The urban system in Serbia is unevenly developed, where the population, functions and economic activity are concentrated in the capital and few major cities (Stojanović and Vojković 2005; Živanović and Gatarić 2017). Due to this centralization, small and medium-sized towns have a weak role in regional and local development (Stojkov and Šećerov 2012). Moreover, the attention to small shrinking towns have been extremely weak in the Serbian national planning policy, which further jeopardize their future development and influence their peripheralization (Kühn 2015). This policy trend is especially pronounced in post-socialist CEE countries, where metropolitan areas and prosperous centres are favoured in regional and national spatial policy (Ehrlich et. al 2012).

Small towns were rarely the focus of research studies in Serbia. Their demographic potential was highlighted (Kanazir 2016), their development characteristics and potential were investigated (Spasić and Petrić 2006; Filipović et al. 2016), but they were not investigated in the context of shrinkage. They were considered only within the overall urban system (Djurkin et. al 2021; Antonić et al. 2020). Considering the diversity and influence of the regional context on the development of small towns (Servillo et al. 2014), it is important to identify the involved factors and their different impacts in the shrinking process.

This research therefore aims to determine the factors that influence the shrinkage of small towns in the Region of Southern and Eastern Serbia (RSES) and establish a typology of small towns based on shrinking characteristics that would enable the shaping of policies for their recovery and future development. RSES was chosen as the most economically underdeveloped region in Serbia, with pronounced problems of depopulation and emigration. The research builds on the previous results achieved in the doctoral dissertation (Ljubenović 2022), conducted for the period 2002–2011. The paper tries to answer the question whether the small towns' shrinkage in RSES forms similar patterns based on which it is possible to group them. At the same time, the goal is to see if it is possible to determine different types of small shrinking towns on a relatively small sample size.

2 Study area, data and methods

2.1 Study area

The research area is the territory of the Region of Southern and Eastern Serbia, which is one of the five statistical regions of Serbia defined by the Law on Regional Development (see the »Official Gazette of RS«, no. 51/2009, 30/2010 and 89/2015 – other law). The region covers 26,249 square kilometres, or approximately one third of the surface area of Serbia. The region's total population was 1.4 million people in 2022, or 21% of the country's population, and the total GDP reached 15.3% of the country's GDP in 2021. The basic criterion for choosing this region, in addition to being the most underdeveloped region in Serbia, is the dominant presence of small towns in the network of settlements with a pronounced process of deindustrialization and economic stagnation (Filipović et al. 2016).

Small towns were defined by combining ESPON's typology of small and medium-sized towns (ESPON 1.4.1. 2006; Servillo et al. 2014), definition of shrinking cities (Wiechmann and Wolff 2013) and the statistical territorial division of Serbia. The lowest threshold for identifying shrinking cities was set by the EU COST Action »Cities Regrowing Smaller« (CIRES), defining shrinking cities as a densely populated urban areas with a minimum of 5,000 inhabitants. In Serbia, settlements are divided into *urban* and *other* according to administrative-legal criteria. Based on the above elements and sources, small towns were defined as urban settlements with a density of more than 300 inhabitants per square kilometre and a population between 5,000 and 25,000 inhabitants. To determine the population density, the size of the urban settlement was used, or, if the urban settlement included large areas of undeveloped land, the size of the construction area defined by the General Regulation Plan was used. According to these criteria, 23 small towns out of 49 urban settlements were defined in the Region of Southern and Eastern Serbia. Due to incomplete statistical data, 4 small towns were excluded from the analysis, due to a lack of data, so that the analytical sample consists of 19 small towns (Figure 1).

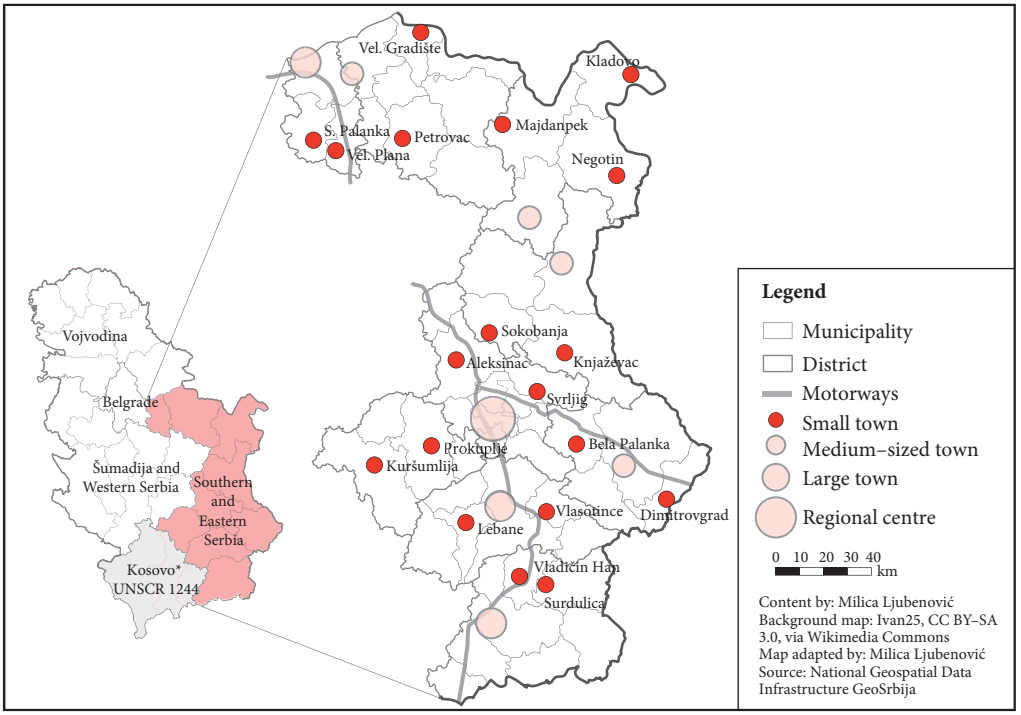

Figure 1: The position of RSES within the territory of the Republic of Serbia and analysed small towns.

2.2 Data source

The identification and analysis of small shrinking towns relies primarily on statistical data from the fields of demography and economics. As a source of demographic data, the Census books of 2002, 2011 and 2022, as well as data from the database of the Statistical Office of the Republic of Serbia (https://www.stat.gov.rs) were taken, while for economic data, the annual publications Municipalities and Regions published by the Statistical Office of the Republic of Serbia were used. The lowest level for which statistical data is collected in Serbia is the settlement level, at which only a small number of indicators are available (number of inhabitants, age of the population and number of abandoned apartments). For other indicators, therefore, data were taken at the municipality level. The population density change was calculated using the maps of the CORINE Land Cover database from 2000, 2012 and 2018 by which the built-up area was determined.

2.3 Identification of urban shrinkage

In order to identify small shrinking towns in RSES, indicators of urban shrinkage were observed within three groups: demographic, economic and spatial indicators. Population loss is considered as the main indicator of urban shrinkage (Turok and Mykhnenko 2007; Haase et al. 2012), and it is most frequently supplemented with additional demographic and economic indicators that are adapted to the goals and scope of analysis, as well as data availability (Gatzweiler et. al 2003; Wolff 2010; Hartt 2018). Indicators related to the spatial manifestation of urban shrinkage are less frequently used, and mainly for mapping housing vacancies and a perforation pattern of shrinking (Kabisch et al. 2006; Haase et al. 2012).

It was necessary to adapt certain indicators to the context of the development of small towns in Serbia, as well as to the available data. A threshold of urban population decline of at least 0.15% per year was adopted in accordance with the recommendations of the CIRES project (Wiechmann and Wolff 2013), and in order to avoid classifying towns that are in temporary stagnation as shrinking towns. Given that the urban shrinkage of small towns is closely related to the shrinkage of rural settlements that surround them (Božić 2017), population change was also observed at the municipal level. Furthermore, other demographic indicators that additionally determine demographic trends and changes in shrinking towns were defined and they are given in Table 1.

Economic indicators were defined based on theoretical recommendations and available data in Serbia (Table 1). The Republic Statistical Office of Serbia monitors economic indicators at the municipal level. Due to the great economic decline during the transition period in Serbia, it was more convenient to monitor the economic development of small towns by comparing the indicator values with the national average.

In Serbia, there is no record of most of the spatial indicators used for urban shrinkage research, which makes their monitoring impossible. For these reasons, the available indicators were used: the decline in population density (adjusted data) and the increase in abandoned apartments (data obtained from Census books and CORINE Land Cover database).

Considering that there are no clearly defined thresholds for the criteria, except for the criterion characterized by population decline, their values were adapted to the national and local context, and their comparison was made with the average values at the national level. For the migration balance, the regional average was used because the national average for internal migration is zero. Values were taken for census years at the end of each period. By reviewing the data, the rule was adopted that a small town could be identified as a shrinking town if, in addition to the population decline in the urban settlement, it fulfilled most of the other criteria within its categories, during one inter-census period. The conditions for identifying small shrinking towns can be expressed in the following form: (D_0, min 50% D_{1-6}, min 50% E_{1-5}, min 50% S_{1-2}). The labels are described in the Table 1.

The period for observing urban shrinkage varies between studies and it is usually the period from the moment of population growth reversal. In RSES, as well as in Serbia in general, population decline has first occurred during the 1990s and intensified since 2000. However, the period during the 1990s was characterized by the dissolution of the country, wars on the territory of the former Yugoslav republics, political and economic isolation (Uvalić 2007). These events aggravate the tracking real demographic and economic trends. For these reasons, the period 2002–2022 was chosen as a representative time frame of the research, whereby two intercensal periods 2002–2011 and 2011–2022 are used to identify shrinking towns.

Table 1: Indicators and criteria of urban shrinkage of small towns in RSES (national average was used as critera, except for regional average for migration balance).

Label	Indicator	Criterion	National / Regional Average		Source
			2002–2011	2011–2022	
	Demographic				
D_0	Population change rate (urban settlement)	<–0.15% per year	<0.14%	<–0.32%	Census of population, households and apartments in in the Republic of Serbia (2002, 2011, 2022)
D_1	Population change rate (municipality)	< national average	<–4.15%	<–11.00%	
D_2	Natural increase rate	< national average	<–5.2‰	<–7.0‰	Statistical Office of the Republic of Serbia database
D_3	Fertility rate (children per woman)	< national average	<1.4	<1.6	
D_4	Migration balance (per 1,000 inhabitants)	< regional average	<–1.3	<–1.9	Statistical Office of the Republic of Serbia. Demographic Yearbook (2002-2022)
D_5	Total dependency ratio*	> national average	>43%	>55%	Census of population, households and apartments in in the Republic of Serbia (2002, 2011, 2022)
D_6	Share of elderly population	> national average	>15.6%	>21.0%	
	Economic				
E_1	Average earnings	< national average	<RSD37,976	<RSD65,864	Statistical Office of the Republic of Serbia Municipalities and Regions (2002–2022)
E_2	Budget revenues	< national average	<RSD29,700	<RSD56,521	
E_3	Purchasing power change coefficient	> national average	>0.8	>0.8	
E_4	Employment change coefficient	< national average	<1.0	<1.3	
E_5	Unemployment change coefficient	> national average	>0.8	>0.7	
	Spatial				
S_1	Population density of the built-up area change coefficient	< 1.0	no data available	no data available	Census of population, households and apartments in in the Republic of Serbia (2002, 2011, 2022) CORINE Land Cover database
S_2	Change in the number of abandoned apartments	> national average	>–1.2%	>–1.3%	Census of population, households and apartments in in the Republic of Serbia (2002, 2011, 2022)

* Note: Total dependency ratio = Population (0–14) + Population (65+)) / Population (15–64)

2.4 Typological classification

A quantitative typology was formed based on the grouping of small towns with similar characteristics of shrinkage. With that goal, principal component analysis was first used, which reduced the number of influential factors and removed probable multicollinearity, on the basis of which the cluster analysis was then performed. The data were processed using the IBM SPSS Statistics software.

2.4.1 Principal component analysis

Principal component analysis (PCA) is a statistical technique that is used to reduce a larger number of variables to a small set of factors that explain most of the variance (Mooi and Sarstedt 2011). By defining the basic structure of the data, PCA is an excellent starting point for cluster analysis (Lu et. al 2011). Fifteen variables which characterize the urban shrinkage of small towns in RSES in the period 2002–2022 were selected as input variables for PCA (Table 2).

The application of PCA analysis implies the fulfilment of certain conditions in order to reach reliable and relevant results. Selected variables should be sufficiently correlated which was checked by correlation matrix, The Kaiser–Meyer–Olkin (KMO) statistic and the Bartlett's test of sphericity (Mooi and Sarstedt 2011).

PCA transforms the original set of correlated variables into a smaller number of independent uncorrelated principal components (PC). The first PC explains most of the variance in the data, and each subsequent one accounts for as much of the remaining variability as possible. To determine the number of extracted factors Eigenvalue and Scree plot is usually used (Mooi and Sarstedt 2011). To facilitate the interpretation of the factors varimax rotation was used as the most prominent one. For evaluation of the obtained solution, the correlation matrices' residuals were checked.

2.4.2 Cluster analysis

Factor scores obtained in PCA analysis are used as input variables for cluster analysis (CA), a statistical method for grouping objects within homogeneous or compact groups based on their similarity (Kovačić 1994). Although it is usually used to group a number of objects, there is no generally accepted rule of thumb regarding minimum sample sizes and the number of clustering variables (Mooi and Sarstedt 2011). The procedure is sensitive to low variation of the parameters, which may lead to the building of unrepresentative clusters and affect the credibility of the analysis. Therefore, the selection of data in accordance with the objective of the analysis must be carefully considered.

In this research, hierarchical and non-hierarchical methods were applied, following a recommendation to determine the number of clusters using hierarchical method, which is then used for conducting a non-hierarchical method (Mooi and Sarstedt 2011).

Table 2: Selected variables for PCA analysis.

Label	Variable	Period / Year
	Demographic variables	
PDU	Coefficient of population decline of the urban settlement	2002–2022
PDM	Coefficient of municipal population decline	2002–2022
NI02	Natural increase (per 1000 inhabitants)	2002
NI22		2022
MB02	Migration balance (per 1000 inhabitants)	2002
MB22		2022
EP02	Share of elderly population	2002
EP22		2022
	Economic variables	
S02	Average salary compared to the national average	2002
S22		2022
PP02	Purchasing power	2002
PP22		2022
UR02	Unemployment rate	2002
UR22		2022
	Spatial variable	
DR	Population density of the built-up area change rate	2002–2022

Hierarchical method is based on the process of successive merging of objects in a group (Kovačić, 1994). The object similarity measure was determined using Ward correlation and squared Euclidean distance. The final result of the hierarchical cluster analysis is displayed graphically in the form of a dendogram, and the division into groups can be done by cutting the dendogram at the appropriate height.

The non-hierarchical method implies a predefined number of clusters. K-means procedure was used, according to which the object joins the group that has the closest centroid (Kovačić 1994). The clustering process is repeated by determining new centroids until a homogeneous cluster structure is achieved. The significance of the differences between the clusters was tested using analysis of variance (ANOVA).

3 Results

3.1 Identification of small shrinking towns in the Region of Southern and Eastern Serbia

Small towns have experienced widespread shrinkage in RSES, with 14 out of 19 (74%) shrinking according to the set criteria from 2002 to 2011 and 12 (58%) from 2011 to 2022 (Table 3). Only one town, Prokuplje, did not record a decline in any period and this town was not taken into account for the classification. On the other hand, in the period 2002–2011, there were only two towns that fulfilled all the criteria, while in the following period there was none. It is interesting that in the period 2011–2022, only Kladovo recorded a population growth of the urban settlement but it met all other demographic and economic shrinking criteria. The causes of such changes probably lie in the different values of indicators at the level of settlement and municipality.

Within demographic criteria, the largest number of deviations occur within the aging indicator, which means that aging was not expressed in all towns as at the national level. In addition, the fertility rate is

Table 3: Fulfilment of the criteria of small towns in RSES (values in bold - criteria below 50%).

Town	Fulfilment of the criteria							
	2002–2011				2011–2022			
	D0	D1-6	E1-5	S1-2	D0	D1-6	E1-5	S1-2
Aleksinac	✓	100%	100%	100%	✓	83%	80%	100%
Bela Palanka	✓	50%	80%	100%	✓	83%	**40%**	100%
Dimitrovgrad	✓	67%	60%	100%	✓	83%	**40%**	100%
Kladovo	✓	50%	60%	50%	✗	100%	100%	**0%**
Knjaževac	✓	83%	80%	100%	✓	83%	**40%**	100%
Kuršumlija	✓	83%	100%	50%	✓	50%	60%	100%
Lebane	✓	83%	80%	100%	✓	50%	60%	100%
Majdanpek	✓	67%	60%	100%	✓	67%	**40%**	100%
Negotin	✓	67%	80%	50%	✓	100%	80%	50%
Petrovac	✓	100%	80%	50%	✓	83%	60%	100%
Prokuplje	✗	50%	100%	50%	✓	50%	**40%**	100%
Smederevska Palanka	✓	83%	100%	100%	✓	100%	60%	100%
Sokobanja	✓	100%	100%	100%	✓	67%	80%	100%
Surdulica	✗	67%	100%	0%	✓	67%	80%	50%
Svrljig	✗	67%	80%	50%	✓	83%	60%	100%
Velika Plana	✗	67%	100%	100%	✓	67%	80%	100%
Veliko Gradište	✗	50%	80%	100%	✓	83%	60%	100%
Vladičin Han	✓	67%	80%	100%	✓	67%	**40%**	100%
Vlasotince	✓	67%	80%	100%	✓	50%	60%	100%

higher in most towns compared to the national average. There is greater diversity in the economic criteria, and the only criterion that was met in all municipalities in the period 2002–2011 was the increase in the unemployed. In the following period, there are greater deviations in economic criteria, and even 89% of towns have recorded a greater increase in registered employment compared to the national average. In addition, in 63% of towns, a greater increase in the purchasing power of citizens is noticeable, although the average salary in almost all of them is lower than the national average. These parameters indicate the improvement of the economic position of small towns despite the demographic decline, which confirms the fact that economic factors should also be considered in the process of the shrinking.

3.2 Results of PCA analysis

PCA analysis was performed only for the towns where defined criteria were identified at least in one period, which was 18 small towns. The correlation matrix of the data showed that the variables were sufficiently intercorrelated. Table 4 shows that KMO measure was larger than 0.5 and that the Bartlett's test of sphericity was significant (p=0.000) which indicated that PCA analysis could be further conducted (Mooi and Sarstedt 2011). Communalities were quite high, and ranged from 62.4% to 96.5%.

In this study, out of total l5, four principal components extracted had Eigen value greater than 1, and they contributed 84.7% of the total variability (Table 5), which was in accordance with distinct break in the scree plot (Figure 2).

Table 4: KMO and Bartlett's Test.

Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		0.530
Bartlett's Test of Sphericity	Approx. Chi-Square	269.482
	df	105
	Sig.	0.000

Table 5: Total variance explained.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	4.513	30.087	30.087	4.513	30.087	30.087
2	3.965	26.431	56.517	3.965	26.431	56.517
3	3.031	20.209	76.726	3.031	20.209	76.726
4	1.198	7.987	84.714	1.198	7.987	84.714
5	0.665	4.432	89.146			
6	0.556	3.708	92.854			
7	0.385	2.570	95.424			
8	0.279	1.863	97.286			
9	0.171	1.139	98.426			
10	0.121	0.804	99.230			
11	0.053	0.356	99.586			
12	0.041	0.274	99.860			
13	0.010	0.064	99.924			
14	0.007	0.050	99.974			
15	0.004	0.026	100.000			

Extraction Method: Principal Component Analysis.

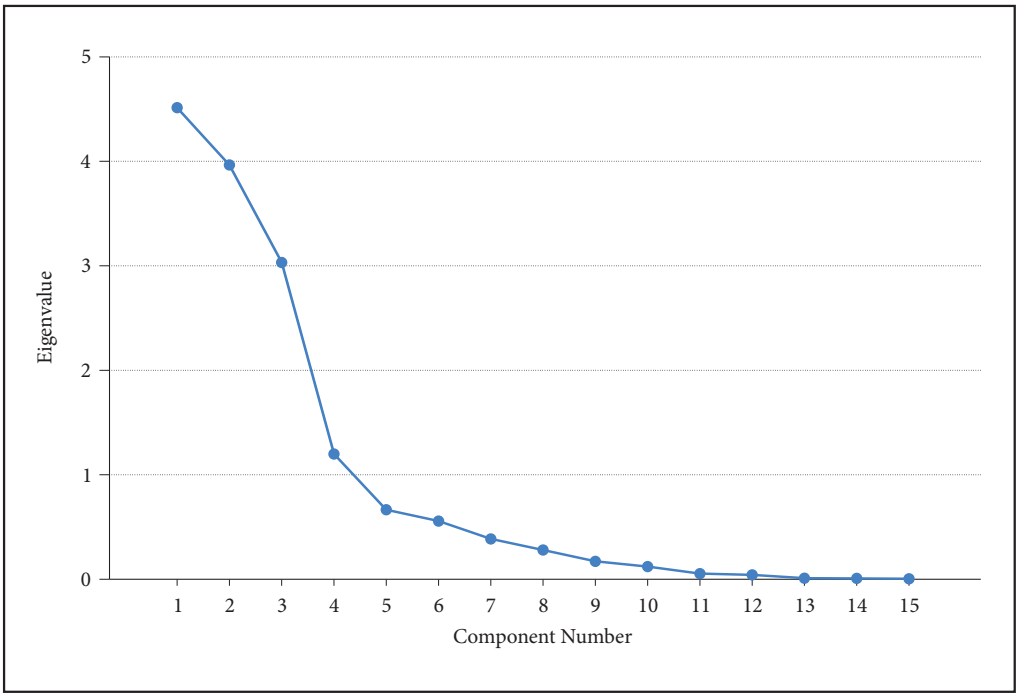

Figure 2: Scree plot.

Table 6: Rotated component matrix (coefficient below 0.3 are suppressed; values with cumulative variances over 50% are bold).

	Component			
	1	2	3	4
PDU		0.901		
PDM				0.793
NI02				0.732
NI22				0.953
MB02		0.770		
MB22			0.691	
EP02			0.933	
EP22			0.642	–0.668
S02	–0.880			
S22	–0.542	–0.696		
PP02	0.885			
PP22	0.605	0.662		
UR02	0.732			
UR22	0.838			
DD		0.780		

Extraction Method: Principal Component Analysis.
Rotation Method: Varimax with Kaiser Normalization.
a. Rotation converged in 5 iterations.

Varimax factor rotation was applied to simplify the interpretation of the discovered factors (Table 6):

- PC1 showed high positive and negative factor loadings on all economic variables, and it was labelled as »Economy«.
- On PC2, high loadings had PDU, MB02 and DD, but also S2 and PP2 which also highly contribute to PC1. This component was labelled as »Urban settlement population and density decline«.
- PC3 had high loadings on MB22, ER02 and ER22 and was labelled as »Age and migration«. – Variables PDM, NI02, NI22 and ER22 showed high loadings on PC4, labelled as »Natural increase and municipality population decline«.

The resulting principal components represent the main dimensions of the shrinkage of small towns in the RSES.

Residuals are computed between observed and reproduced correlations. There are 28 (26.0%) nonredundant residuals with absolute values greater than 0.05, which is less than the required maximum of 50% (Mooi and Sarstedt 2011).

3.3 Results of cluster analysis

The obtained results from a hierarchical analysis indicated that two to four clusters could be distinguished, whereby Majdanpek stood out as an outlier (Figure 3). These results made it possible to implement a k-means by assigning a different number of clusters. Using ANOVA, statistical significance was compared for two, three and four clusters. The means between groups differed from each other the most for the solution with four clusters. Cluster membership and their basic characteristics are given in Figure 4 and Table 7. Majdanpek

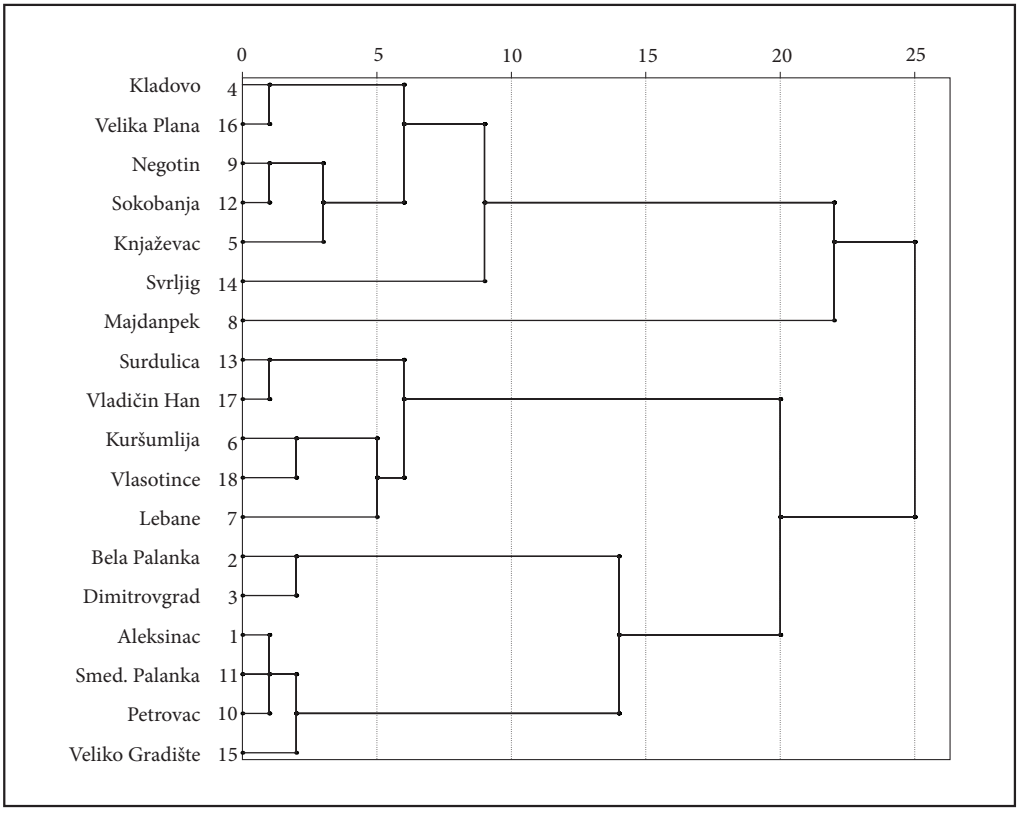

Figure 3: Dendrogram obtained by hierarchical analysis.

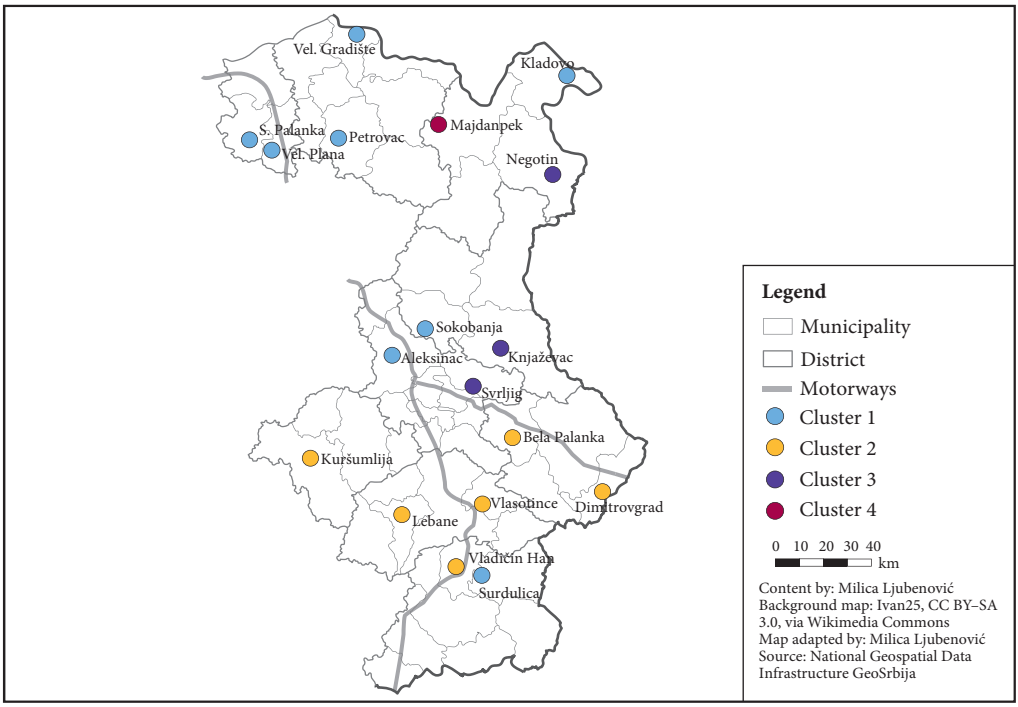

Figure 4: Clusters of small shrinking towns in RSES.

Table 7: Identified clusters and their characteristics.

Cluster			
Custer 1 The most stable economy	Cluster 2 Emigration and unemployment	Cluster 3 Extremely negative natural increase and aging	Cluster 4 Pronounced population decline and emigration
Towns			
Aleksinac Kladovo Petrovac Smederevska Palanka Sokobanja Surdulica Veliko Gradište Velika Plana	Bela Palanka Dimitrovgrad Kuršumlija Lebane Vladičin Han Vlasotince	Knjaževac Negotin Svrljig	Majdanpek
Characteristics			
Lower population decline in urban settlement and municipality Average earnings 75–100% of the national average The highest purchasing power Smallest changes in purchasing power The lowest percentage of unemployed	Pronounced population decline in urban settlement and municipality Pronounced negative migration balance A lower proportion of the elderly The lowest average earnings Low purchasing power with the highest increase The highest unemployment rate The highest density decline	The most pronounced population decline in municipality The most pronounced negative natural increase The largest share of elderly Low average earnings The lowest purchasing power with the highest increase	The most pronounced population decline (urban settlement and municipality >35%) The most pronounced negative migration balance The lowest proportion of old people in both periods The average salary in 2022 is above the national average Highest purchasing power The largest employment rate

stood out again as a separate cluster, which was a consequence of the large differences in the values of the variables compared to other towns.

Clusters are quite heterogeneous in terms of settlement size and economic functions. However, some similarities, by which they differ from each other can be observed (Figure 4 and Table 7).

Cluster 1 is mainly located in the northern part of the region. Six towns belonging to this cluster are located in the vicinity of a high-way, and two towns are situated on the right bank of the Danube River. This position along transport routes (road and water) influenced more favourable economic change and lower population decline.

Towns grouped in cluster 2 are positioned in the southern part of RSES. One of the cause for pronounced emigration and unemployment in these towns is the change in their territorial position regarding transport connectivity. Naimely, transit roads used to pass through these towns, but with the construction of the highway in the 21st century, they remained in its hinterland.

Cluster 3 contains two border towns and one town (Svrljig) which developed in a shadow of a regional center. They are all characterized by a peripheralization, caused in the first two towns by remote location, and in the third by unequal power relations between regional center and small town. As a consequence, these towns face extremely negative natural increase and aging.

Cluster 4 contains only one town that is a typical example of a small monofunctional town, unique in RSES. The decline of the most developed economic branch coused a drastic population decline.

4 Discussion

4.1 Characteristics of urban shrinkage of small towns and cluster analysis

The results of the analysis of the development trends of small towns in Serbia indicate that the phenomenon of urban shrinkage is present to a large extent, but that the trends differ according to individual parameters. The population decline is widely present and increasingly intense in almost all towns. In terms of demographic parameters, the biggest deviation occurs in the age structure because the aging process has not yet affected all towns significantly similar to findings of Bański et al. (2023). However, the change in the demographic structure towards aging is more noticeable in the previous decade and bearing in mind the ubiquitous decline of natural increase, this process will be more pronounced in the future. There are greater variations and deviations in economic criteria, especially in terms of registered employment and purchasing power of citizens. On the one hand, this can be interpreted as a slight economic recovery of certain towns, but it should be noted that formal employment and unemployment do not fully reflect the labour market. In all towns, there is a decrease in population density, which indicates that there is no spatial expansion of towns opposite of process occurring in medium-sized and larger cities (Miljanović et al. 2023). The increase in abandoned apartments is evident in almost all towns, but it does not follow the dynamics of the population change, which confirms that this phenomenon also depends on other factors such as the number and structure of households and the real estate market (Haase et al. 2016). The results of the analysis in this research confirm previous claims that small towns in Serbia are heterogeneous ensemble (Spasić and Petrić 2006; Filipović et. al 2016; Grčić et al. 2024), which is also the case in other countries (Stoica et al. 2020). There are different causes and trajectories of shrinkage of small towns in RSES, affected by the combined effects of national and local factors. However, the possibility of forming different clusters confirms that they could be grouped by similar characteristics of shrinkage. The clusters obtained in this work are almost identical to the clusters in the previous research on the small shrinking towns in the same region for the period 2002–2011 (Ljubenović 2022). Such results indicate that similar development tendencies continued in the towns in the next decade, as well as that this classification procedure can be used for long-term planning of the strategic development of small shrinking towns.

The formed clusters show that the shrinkage is not related to the size of the small town, as suggested also by Pirisi and Trócsányi (2014). On the other hand, the patterns of urban shrinkage are closely related to the territorial position and traffic connectivity (ESPON 1.4.1. 2006; Domhardt and Troeger-Weiß 2009; Cox and Longlands 2016). However, proximity to main transport axis shows two varieties. On the one hand, towns that developed along the highway over a longer period of time show more stable economic development, while the others were negatively affected by the recent construction of the highway.

Small towns at a shorter distance from others, especially larger towns, should have more favorable preconditions for development (ESPON 1.4.1. 2006; Restrepo Cadavid et al. 2017). Cluster analysis showed that this factor did not have a major impact on cluster formation, which can be explained by the fact that even larger cities in RSES are stagnating or shrinking. Border towns show also diversity and belong to different clusters, which is similar to findings of Avdić et. al (2022).

The intensity of population change, used in many studies as the base for the typology of shrinking cities (Turok and Mykhnenko 2007; Hill et al. 2012; Wiechmann and Wolff 2013) did not have a major impact on cluster formation and was of a similar scale in different clusters, except in the case of cluster 4, which consists of one town with the most pronounced decline.

4.2 Recommendations for guiding cluster development

The governance and planning system in Serbia did not have a positive impact on the development of small shrinking towns (Ljubenović 2022). Issues of urban development are mostly left to the local level and considered within general urban plans or lower planning levels (Bajić Brković 2010). Certain demographic and economic problems of small towns have been treated to some extent in national and regional documents, however, urban policy in Serbia has so far failed to achieve visible effects and improve the quality of life in small towns. The approach to small towns cannot be unique (Knox and Mayer 2009; Servillo et al. 2014; Stoica et al. 2020), as confirmed by the results of the cluster analysis. A special approach and program measures for directing the development of the clusters of shrinking small towns in RSES should be formed, addressing the dominant factors of shrinking. Cluster 1 consists of economically relatively stable towns, which actually did not go through large dynamics of economic changes. Given the better prerequisites for development compared to other clusters, possible measures could be aimed at improving and promotion of an alternative living environment compared to big cities, an approach that, for example, in France has become a tool of local actors for the development of small towns (Kwiatek-Sołtys and Mainet 2014).

The economic dimension of urban shrinkage should be influenced the most in towns of Cluster 2, thus strategies should be directed towards building local economic resilience and designing new economic directions for the town development (Cox and Longlands 2016). Inter-municipal cooperation is also important for stimulating the economy of small towns and ensuring better quality and efficiency of services (Siljanoska et al. 2012; Servillo et al. 2014).

Due to the unfavourable demographic structure of Cluster 3, it is necessary to develop policies for the integration of the elderly population into society (Hospers 2014). Urban-rural partnerships can expand the capabilities of small towns in the production of public goods, achieve economies of scale by improving the provision of public services, or develop entirely new economic opportunities (Valtenbergs et al. 2015; Igić et al. 2023).

A major limitation of future development of town in Cluster 4 is the monostructural economy, as well as the distance from other settlements. For such towns, a wider regional context and cross-border cooperation are recommended in order to become important centres independent of their location (Servillo et al. 2014), as well as the development of a specific specialization of the local economy (Leetmaaa et al. 2015).

5 Conclusion

The identification of small shrinking towns in Serbia required certain adaptations of criteria of shrinkage to national and local context. A major limitation for the identification and comparison of individual indicators in Serbia is the insufficiently developed statistical system and the lack of data, as well as their incompleteness for the lowest spatial units.

PCA and CA singled out four groups of towns according to pronounced characteristics of shrinkage in RSES, which showed that in addition to the same global and national conditions, urban shrinkage had recognizable local specificities. Specific characteristics could be distinguished in each cluster, i.e. a group of shrinking towns differed from others. The results of the cluster analysis also indicate that the tendencies of the development of small shrinking towns correspond to earlier research (Ljubenović 2022). This classification procedure can be used for long-term planning of the strategic development of small shrinking towns.

In addition to the data and indicators used in the analysis, a difference between the clusters is recognized in territorial position and connectivity. This indicated that additional spatial determinants such as accessibility, traffic connectivity and the location of the town in relation to other settlements should be included in the further analysis of small shrinking towns, and especially in the process of shaping development policies.

The application of this methodology is also possible for other regions in Serbia, as well as outside Serbia. In order to implement this method of classification, it is necessary to have variations in parameters, and if they were not expressed, it would be necessary to introduce additional quantitative determinants in relation to which the classification could be carried out. Lack of accurate data for some key variables could also affect the formation of clusters.

Considering the prevalence of urban shrinkage in small towns in Serbia, planning their future development requires more attention in the Serbian national planning policy. Accordingly, the formulation of a special national policy for the development of small towns would be necessary in order to achieve a more balanced territorial and urban development of the country. Such a document could contain special program measures coordinated according to the typology of small shrinking towns. This would identify priority strategies depending on the key characteristics of urban shrinkage.

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