

URBAN HIERARCHY IN SERBIA

*Bojan Đerčan, Milica Radaković, Miloš Ostojić,
Maja Mirković, Smiljka Obrenov, Jan Vozar¹*

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ABSTRACT: *Despite numerous urban studies that analyzed various aspects of Serbia's urban network, little attention was paid to examining the phenomenon of urban hierarchy and urban primacy. Therefore, the aim of this paper is to examine the nature, level and progression of the urban hierarchy in Serbia, as well as its causes and consequences. In achieving these goals, the paper begins with a review of urbanization in Serbia and the methods of its measurement, followed by a discussion of the results obtained. This paper uses data from the Statistical Office of the Republic of Serbia on the number of inhabitants and active population employed in the tertiary-quaternary sector in the period between 1971 and 2011. This paper tested the Rank-size rule, known also as Zipf's law, Urban Primacy Index, and Schmook and Rochefort methods to display the results. This paper concluded that urban primacy is an obvious phenomenon in Serbia. There is a clear distinction between the polycentric urbanized Vojvodina, a somewhat less urbanized central Serbia, and a large range in Belgrade's functional capacity.*

Keywords: *Serbia, urbanization, centrality, hierarchy, cities*

INTRODUCTION

The effectiveness of the urban system in any country largely depends on the distribution in the size and distance of urban centres. This determines whether the urbanization process is the same throughout the region or is centralized (Nicholson, 2003). The urbanization pattern in Serbia was mainly oriented to larger cities.

The Republic of Serbia is going through intensive processes of depopulation and demographic aging, with pronounced regional disproportions of the population. Intensive migrations have resulted in the concentration of the population in all major urban areas and the depopulation of large areas of the Republic of Serbia.

The pronounced regional unevenness between underdeveloped, bigger part of the area and developed territorial areas and segments of the Republic of Serbia is a result of the joint influence of numerous factors and their causal relations (Vujnić, 2014).

¹ University of Novi Sad, Faculty of Sciences, Department of Geography, Tourism and Hotel Management, 3 Trg Dositeja Obradovića, 21000 Novi Sad, contact: dgt.milica.radakovic@student.pmf.uns.ac.rs

A wide spectrum of inherited cultural, historical, demographic, economic, infra-structural, social and political parameters, respecting the natural and geostrategic position of certain areas, have decisively influenced on the uneven regional development of our country. The consequences on the territory of the Republic of Serbia are evident - huge intraregional and interregional disparities impede development and encourage migration flows. The large and strategically important areas of the Republic of Serbia have remained uncovered in population terms, and their resources are unused. At the same time, there is an excessive concentration of population and economy in more developed centres, which in some way produced negative consequences in the economic, social, spatial and environmental spheres of the same (Aničić, Laketa, Vukotić, 2011).

At first glance, it can be said that the urban network of Serbia is characterized by a favourable distribution of urban settlements, but a little more detailed analysis of the concentration of population and functions show certain problems in them. About 26% of urban population of Serbia without Kosmet live in Belgrade. Its dominance is indicated by the index of urban primacy with value of 6.3 (the ratio of the population of Belgrade and Novi Sad). The discrepancy between the population of the leading and other urban settlements indicates that Serbia does not have a properly and evenly developed urban system, that is, that the flows of urbanization were not timely directed.

In Serbia, many forms of more and less urbanized areas and several forms of regional urban systems have been identified, and their spatial and functional organization has been established. However, Serbia is insufficiently urbanized, and in terms of the continuity of lasting and spatial forms of manifestation of urbanization, there is a clear distinction between polycentrically urbanized Vojvodina, somewhat less urbanized central Serbia, with an irregular hierarchical structure in urban settlement systems and a large range between the functional capacity of Belgrade and other centres and the low-urbanized area of Kosovo and Metohija (Ćurčić, 1992).

Although a large number of authors dealing with urban processes and urban structures, through their works advocated for the polycentric and balanced development of the network of urban settlements, this concept has not been realized in the practice of regional planning and regional development. It was only during the development of the Spatial Plan of the Republic that an exact analysis of all elements and factors of regional development was carried out, which was used as a base for the strategy whose implementation will carry out demetropolisation of Belgrade agglomeration and mitigate the dysfunctionality in the system of settlements and start functional balancing.

REVIEW OF URBANIZATION IN SERBIA

The main settlements in Serbia are mainly of Roman and Byzantine origin, and some settlements have even older foundations from prehistoric times. The oldest settlements in this area originate from the Mesolithic, and famous cultures are Lepenski Vir, Starčevo and Vinča. The towns that appear during the Roman Empire are: Sirmium (Sremska Mitrovica), Singidunum (Belgrade), Naisus (Niš), Viminacium (Kostolac), Horeum Margi (Ćuprija), Ulpiana (Gračanica), Kapedunum (Užice), Remeziana (Bela

Palanka), Iustiniana Prima near Lebane) and others. During the wars, many theretofore major towns lost their importance, or completely disappeared, renewing on the first occasion.

At the beginning of the Middle Ages and in the Ottoman period, those towns that had the most favorable geographical position were held. Such were Belgrade, Niš, Smederevo, Kruševac, Priština. The favourable conditions were along the major rivers (Danube, Sava, Tisa, Morava), accompanied by the main roads of that time. A significant part of today's cities is based on the foundations of cities that are mentioned in medieval chapters and sources. Some of them are Belgrade, Šabac, Valjevo, Smederevo, Užice, Jagodina, Niš, Čačak, Kruševac, Priština. During the Habsburg-Ottoman wars, the cities of Serbia were repeatedly subjected to Habsburg and Ottoman rules. Primacy was taken by towns at borders as places where trade developed. If the environment was economically viable and if the town was established at the intersection of important roads, it often became commercially strong in a short period of time (Obrenovac, Mladenovac).

Urban population was small. In 1834, this number was only 41,347 inhabitants and slowly grew. In 1874, Belgrade had only 27,605 inhabitants. There was an important ethnic and religious distinction between rural and the urban population. In 1834, the density of population in the Principality of Serbia amounted to 18 inh./ km², and in 1874 it was 36 inh./km². Due to high natural growth and immigration, the density of population is increasing to 56 inh./km². In 1880 in Vojvodina, the population density was 53 inh./ km², and in 1910, 68inh/km². Between the two world wars it was increased from 51inh./km² in 1921 to 72.5 inh./ km² in 1940. During the Second World War, some Vojvodina cities lost large numbers of inhabitants (Vršac, Senta and Sremska Mitrovica), due to occupation terror, persecution of Jews (Senta, Novi Sad) and emigration of Germans (Vršac) (Bubalo-Živković, 2016).

The development of settlement during the 19th century and in the first half of the 20th century shows characteristics typical for the agrarian environment of a very low degree of urbanization and high agrarian overpopulation. Migration is a process that has caused the greatest differences in the demographic development of rural and urban areas. Village-city migration disrupted the existing balance and relative independence of demographic development, creating on the one hand depopulation and discharge of rural areas, and on the other hand an increased number of inhabitants in urban areas. The increase in urban population was also due to natural increase, but also to the change in the status of certain settlements. According to the population census in 1953, about one-fifth of the total population lived in urban settlements (22.5%), and about two-thirds of the active population (67%) were agricultural. Vojvodina was most urbanized with 29.5% of the urban population, then central Serbia with 21.2% and at the end was Kosovo and Metohija with only 14.6%. In the period 1961-1971, the urban population growth rate was 4.2%, and the degree of urbanization rose to 40.6% (central Serbia 40.8%, Vojvodina 48.8%, Kosovo and Metohija 26.9%). Between 1971 and 1981, the growth rate dropped to 2.4%, and the share of the urban population in the total increased to 46.6% (central Serbia 47.8%, Vojvodina 54.1%, Kosovo and Metohija 32.5 %). In the period 1981-1991, the growth rate was lower - 1.4%, while the degree of urbanization increased to 50.7% (central Serbia 53.5%, Vojvodina 55.7%, Kosovo and Metohi-

ja 37.5%). During this time the urban population increased by 91,386 inhabitants, while the population of other settlements decreased by 161,000 inhabitants.

The spatial and social mobility of the population from rural to urban settlements and from primary to secondary and tertiary sectors of economy affected the succession of the phases of urbanization, which was manifesting territorially and temporally through demographic, functional and physiognomic changes in both urban and rural settlements.

Complex urban systems are composed of several settlements whose links are the result of the interaction of their structural elements and the different degree of hierarchy. They have the character of the functionally urban or, metropolitan regions. They are distinguished by the high degree of urbanization and the large share of the urban population in the total, high employment of labour in non-agricultural activities, diversified functions and stable daily migration of the workforce. The most important representatives of this type of urban systems are Novi Sad, Niš, Kragujevac and Subotica (Bubalo-Živković, 2016).

The Belgrade agglomeration is a complex and dynamic system of urban settlements with a high level of functional and morphological connection with a clearly expressed multilayered hierarchy and a great gravitational influence that goes beyond the state borders. Belgrade is a potential centre of Southeast Europe of first-rate international importance, that is, the centre of the future Euro-Metropolitan region. According to the 2002 Census, the city of Belgrade had a population of 1,574,050, of which 1,280,639 inhabitants lived in urban settlements, or 82.3%. According to the latest 2011 census, there were 1,659,440 inhabitants in the Belgrade region, of which 1,334,844 or 81% made urban population.

As a large agglomeration core of Vojvodina, Novi Sad is a significant part of the conurbation that is expanding towards Belgrade. It is a city that has a significant increase in the number of inhabitants in the last decades, mainly due to migration processes. In 2002, it had 299.294 inhabitants, and in 2011, 377.522 inhabitants.

The city of Niš has 260,237 inhabitants, of which 187,544 inhabitants live in urban settlements (Niš and Niška Banja). If someone applied the socio-geographical method in determining the boundaries of Niš's agglomeration, it would be found that Niš is the centre of a polycentric metropolitan region with over 350,000 inhabitants and a large zone of influence (Bubalo-Živković, 2016).

METHODOLOGY

The subject of the research is the settlements of Serbia which since February 2016 have had the status of the city. The aim of the research is to determine the urban hierarchy and to get a complete picture of the urbanization of Serbia using the census data, starting from 1971, concluding with the last census conducted in 2011. The task of the research is to analyze the population numbers for each city individually through the aforementioned censuses, to draw conclusions about the fluctuations of numbers, bearing in mind historical events and economic, sociological and other causes.

Statistical, cartographic, mathematical, demographic and comparative methods were used for data processing. In ArcMap 10.1., the map of Serbia was digitized in order to graphically display the results.

The rank size rule was first noticed by the German geographer Auerbach at the beginning of the twentieth century. The rule refers to the existence of dependence between the size and the number of cities, that is, the tendency of creating the regular rank of the size of cities in the space. These observations were elaborated later by many authors: Zipf, Stuart, Singer, Berry. These interdependencies were theoretically formulated as the Rank size rule (Berry, Garrison, 1959, Soo, 2002). According to this parameter, it can be expected that one city in a set of cities of a country or region, ranked by size, will have as many inhabitants as the largest city, divided by the city's rank in a set of cities. Therefore, the second settlement in a set will have half the population of the largest one, the third will have one third less than the largest, etc. The rank-size rule for the number of inhabitants by cities known also as the Zipf's law is determined by the equation:

$$S_n = \frac{S_1}{r}$$

where S_n - is the expected number of inhabitants of the city in the hierarchy, S_1 - the number of inhabitants of the largest city, and r - the city's rank in a set. Distribution of settlements is most often represented by a graph with an arithmetic scale on which the function has the shape of a curve. Based on Pearson's correlation coefficient, the degree of matching of distribution of the settlements can be determined.

The American geographer Jefferson (1939) noted that in some countries, a capital city - a primate city is the largest and the other cities are considerably smaller, and this phenomenon was called the Law of the primate city. Many scientists believe that this is due to political and economic opportunities, and the exceptional political, economic and social significance of the capital (Mutlu, 1989; Murray, 2003; Sarkar, Maya, 2013; Yusuf, Shah, 2014). The law of the primate city is calculated on the basis of the index of urban primacy:

$$I = \frac{G_1}{G_2}$$

where I - is the index of urban primacy, G_1 - is the number of inhabitants of the largest city and G_2 is the number of inhabitants of the second largest city. In practice, the three largest cities are most often used for calculation:

$$I = \frac{G_1}{G_2 + G_3 + G_4}$$

Urban primacy is high if the index value is greater than 2. One of the research procedures for determining the degree of development, position and significance of settlements in the network is the Schmook's method for the centrality of settlements (Schmook, 1968). It calculates the centrality as the ratio of the number of active population employed in the tertiary-quaternary sector in the total active population of the region. The centrality is calculated according to the form:

$$C_1 = A_n \cdot \frac{TQ_n}{A_n} - \frac{TQ_r}{A_r}$$

where A_n - is an active population in the settlement, TQ_n - active population employed in the tertiary-quaternary sector in the settlement, TQ_r - active population in the tertiary - quaternary sector in the region and A_r - active population in the region.

The Rochefort's method gives the possibility to graphically display the centrality of the settlement using the equation (Rochefort, 1957):

$$X = \frac{TQ_n}{A_r}, \frac{TQ_n}{TQ_r}$$

Designations in the form have the same meaning as in the Schmook's model, and X and Y are abscissa and ordinate of the coordinate system.

According to the population censuses in 1953, 1961 and 1971 there was a division of settlements based on demographic and statistical criteria in relation to the number of inhabitants and the percentage of the non-agricultural population of the settlement. These censuses included a division into urban, mixed and rural settlements. Urban settlements could have at least 2,000 inhabitants, and only if they had over 90% of the non-agricultural population.

Since the population census in 1981, the administrative and legal criteria have used in Serbia, according to which the settlements are declared as urban by the legal regulations. The settlements have since been divided into the urban and the others.

According to the amendments to the Law on Territorial Organization of the Republic of Serbia in February 2016, Serbia has 26 cities: Sombor, Subotica, Novi Sad, Kikinda, Zrenjanin, Sremska Mitrovica, Šabac, Loznica, Pančevo, Vršac, Smederevo, Požarevac, Valjevo, Užice, Čačak, Kragujevac, Kraljevo, Jagodina, Zaječar, Kruševac, Novi Pazar, Niš, Leskovac, Pirot, Vranje, Priština and Belgrade, which has a special status as the capital city. Data taken from the population censuses was processed in Microsoft Excel 2010.

RESULTS AND DISCUSSION

In the example of the 27 cities analyzed in this survey, Table 1 shows the ratio between the number of inhabitants of the cities according to the 2011 Census and the number of inhabitants these cities should have according to an ideal rank-size rule.

Figure 1 shows the correlation between the regular rank of size and the actual number of inhabitants in cities. The blue line indicates the distribution of settlements by population size, and the red line indicates the distribution of settlements by the rank-size rule.

The Pearson's correlation coefficient between the number of inhabitants of cities according to the 2011 Census and the number of inhabitants according to the rank-size rule of cities is 0.93, which represents a very high positive value of the match.

Table 1. The rank-size rule for cities in Serbia, according to the 2011 Census

Rank	City	Number of inhabitants, 2011	Number of inhabitants by the Rank-size rule
1.	Belgrade	1.394.217	1.394.217
2.	Novi Sad	221.854	697.108,5
3.	Niš	187.544	464.739
4.	Kragujevac	147.281	348.554,3
5.	Priština	145.149	278.843,4
6.	Subotica	96.483	232.369,5
7.	Zrenjanin	75.743	199.173,9
8.	Pančevo	73.992	174.277,1
9.	Čačak	72.148	154.913
10.	Kraljevo	63.030	139.421,7
11.	Smederevo	63.028	126.747
12.	Novi Pazar	60.638	116.184,8
13.	Leskovac	59.610	107.247,5
14.	Valjevo	58.184	99.586,9
15.	Kruševac	57.627	92.947,8
16.	Vranje	54.456	87.138,6
17.	Šabac	52.822	82.012,8
18.	Užice	52.199	77.456,5
19.	Sombor	47.485	73.379,8
20.	Požarevac	42.963	69.710,9
21.	Pirot	38.432	66.391,3
22.	Kikinda	37.676	63.373,5
23.	Sremska Mitrovica	37.586	60.618,1
24.	Zaječar	36.830	58.092,4
25.	Jagodina	36.092	55.768,7
26.	Vršac	35.701	53.623,7
27.	Loznica	18.714	51.637,7

The values of the urban primary index for the censuses between 1971 and 2011 in both ways are shown in Table 2.

Table 2. Urban primacy index

1971	1981	1991	2002	2011
7,371	6,525	7,772	7,318	6,284
2,878	2,409	2,734	2,728	2,504

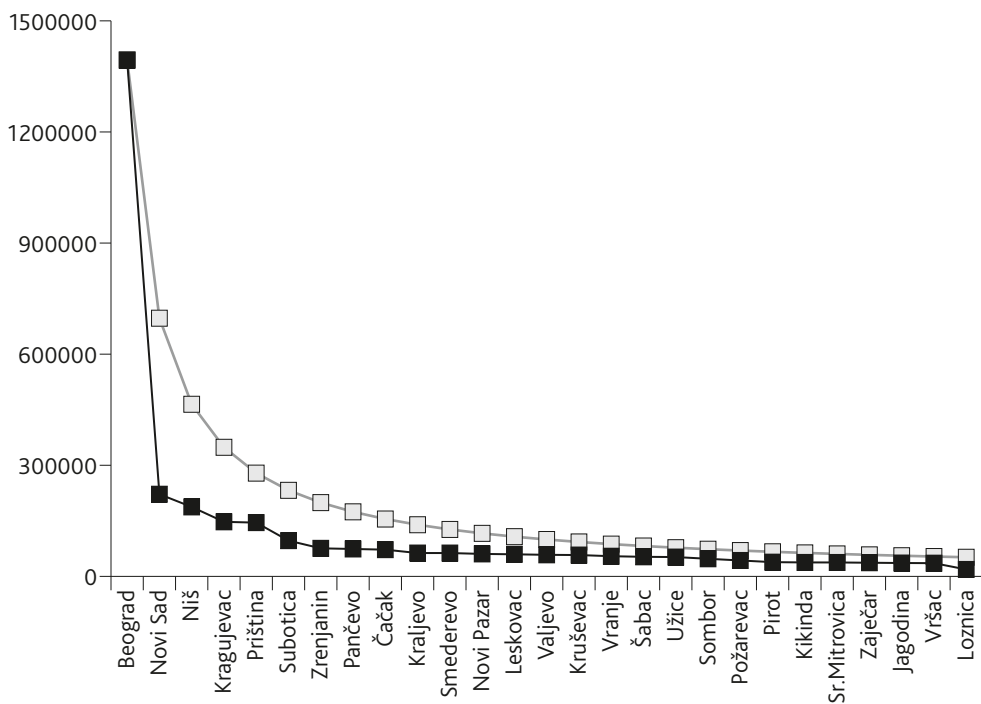


Figure 1. Graphic representation of the rank of the size of the cities in Serbia, according to the 2011 Census

The results show a very high urban primacy index, where the remaining cities in the hierarchy are lagging behind the primate city (Belgrade). Based on both equations, there is a decline in the urban primacy index between 1971 and 1981, and between 2002 and 2011.

Based on Schmook's formula for the centrality of the settlement, positive and negative values were obtained. Positive values refer to the active population in the tertiary and quaternary sectors in large cities, while those with a smaller population have negative values. The reversed situation applies in the share of the active population in the primary and secondary sectors, where the largest cities of Serbia have negative values.

Figure 2 shows a significant deviation of the city of Belgrade from other urban municipalities in the share of the active population employed in the tertiary and quaternary sectors of the economy.

For the purpose of more transparent presentation of results, Figure 3 omitted the capital city from the analysis.

Cartographic appendices include an analysis of cities represented by a symbol of a point of different colours and sizes according to the number of inhabitants in the given census. The smallest circle represents the cities with less than 25,000 inhabitants, followed by those of up to 50,000, 100,000, 150,000, and over 150,000 inhabitants.

According to the Population Census of 1971, the only city with over 150,000 inhabitants is Belgrade. In the second rank are Novi Sad and Niš. They are followed by Subot-

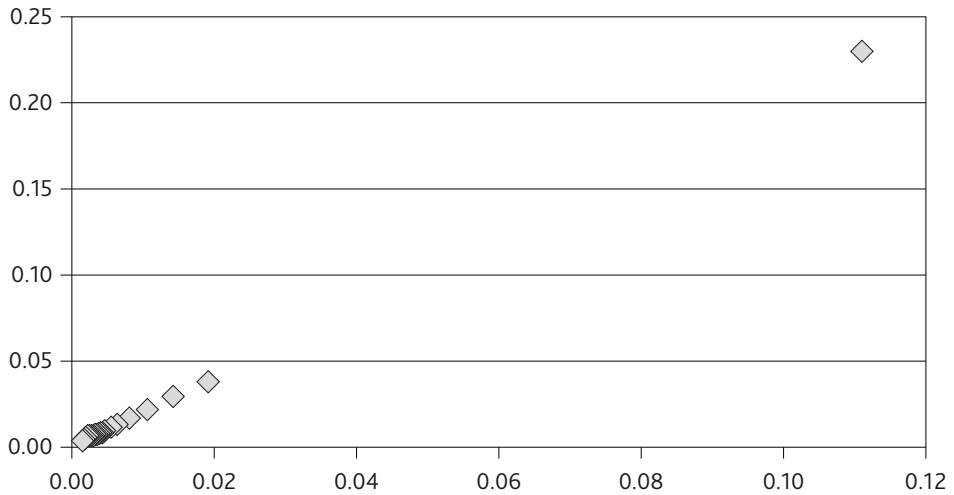


Figure 2. Centrality of settlements depicted by the Rochefort's method

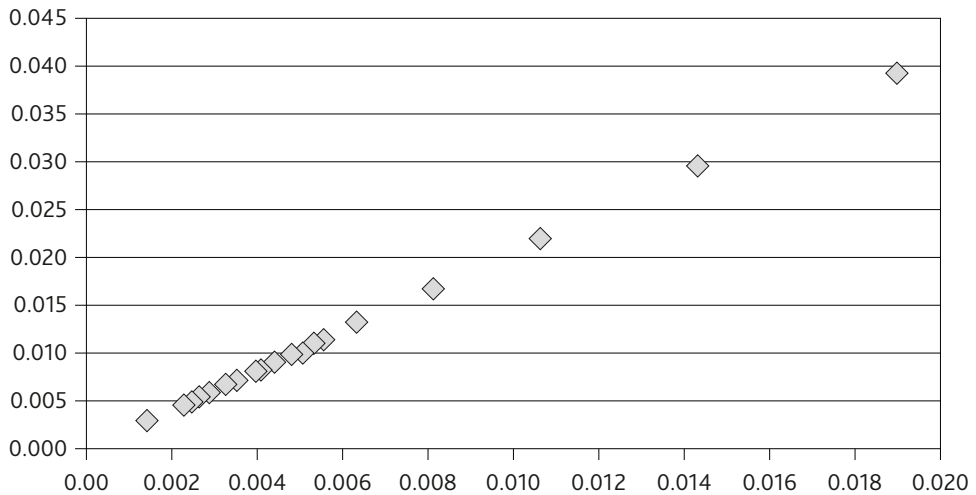
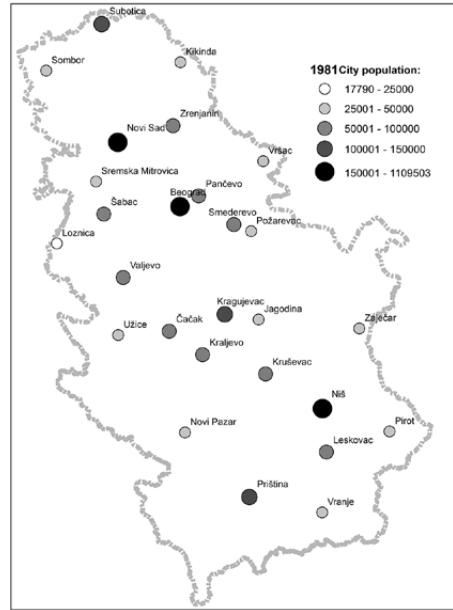
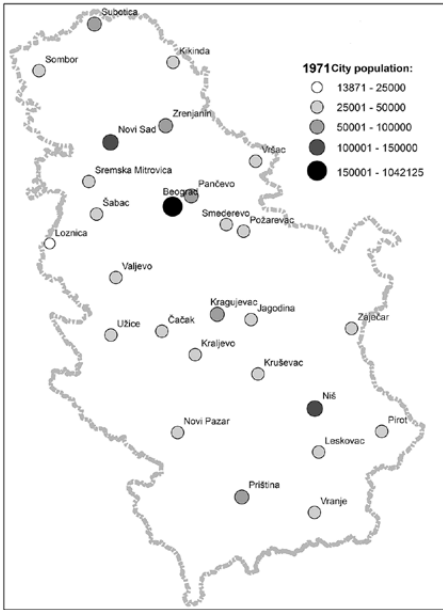


Figure 3. Centrality of settlements depicted by the Rochefort's method without Belgrade

ica, Pančevo, Priština and Zrenjanin. Most cities are in the fourth rank (18). According to the number of inhabitants, Loznica was the smallest city of that year (Appendix 1).

After ten years, the situation improved as cities of lower rank have moved to higher one. Novi Sad and Niš joined to Belgrade. Subotica, Kragujevac and Priština moved to the second rank. Šabac, Valjevo, Čačak, Kraljevo, Kruševac, Leskovac and Smederevo have over 50,000 inhabitants, while Sremska Mitrovica, Sombor, Kikinda, Vršac, Zaječar, Pirot, Vranje, Novi Pazar, Jagodina and Požarevac have no change. Loznica increases the number of inhabitants but still is the smallest city (Appendix 2).

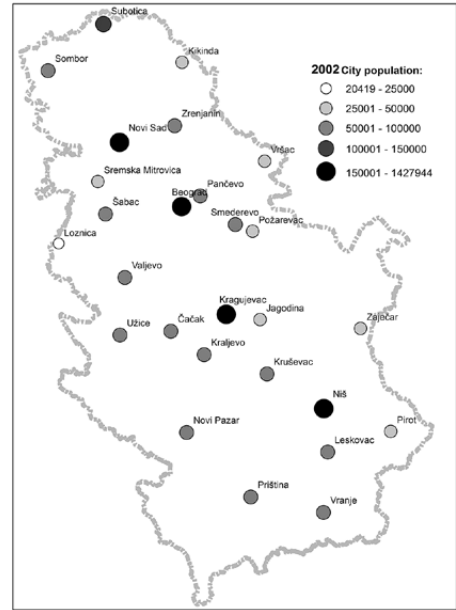
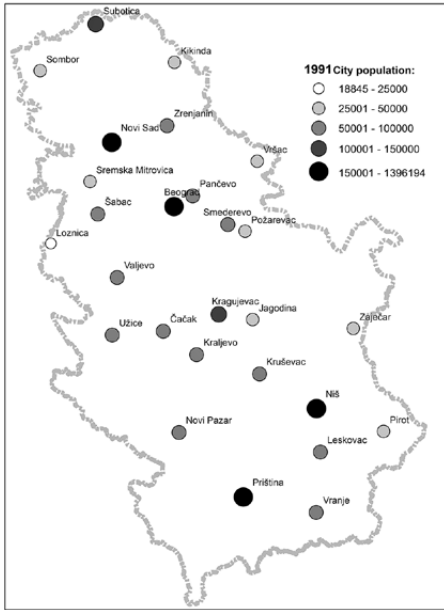


Appendices 1 and 2. Number of inhabitants in the cities of Serbia according to the censuses in 1971 and 1981

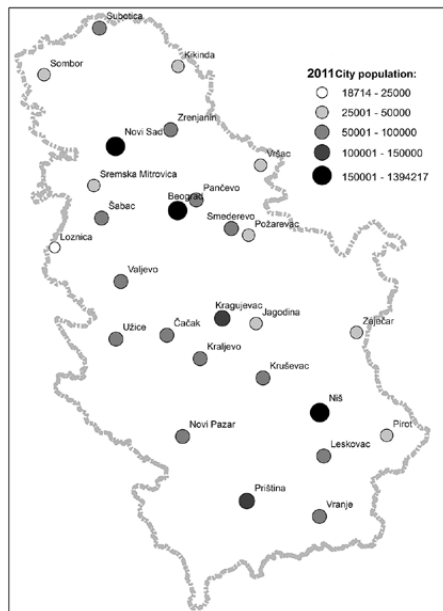
In addition to the aforementioned cities, Priština also had more than 150,000 inhabitants in the next census in 1991. Cities of the second rank now include Subotica and Kragujevac. Novi Pazar, Užice and Vranje exceed 50,001 inhabitants. Sombor, Vršac, Sremska Mitrovica, Požarevac, Zaječar, Jagodina and Pirot remain in the fourth rank, and Loznica is in the fifth (Appendix 3).

According to the 2002 census, Belgrade, Novi Sad, Kragujevac, Niš and Priština are in the first rank in terms of population. This was the census in which Serbia had the most cities in the first rank. Subotica stays alone in the second rank, and Sombor moves from fourth to third rank and joins to those listed in the previous census. In addition to Sombor, all other cities in the lower ranks are unchanged by the number of inhabitants (Appendix 4).

The situation in Serbia according to the 2011 census is as follows: Priština and Kragujevac lose the rank of the first city, so that over 150,001 inhabitants have only Novi Sad, Niš and Belgrade. In the second rank are only Priština and Kragujevac, because Subotica has a reduced number of inhabitants compared to the previous census. Subotica, Zrenjanin, Šabac, Pančevo, Smederevo, Valjevo, Užice, Čačak, Kraljevo, Kruševac, Novi Pazar, Vranje and Leskovac are in the third rank, that is, they have over 50.000 inhabitants. Less than this number have Sombor, Kikinda, Vršac, Sremska Mitrovica, Požarevac, Zaječar and Pirot. Loznica remains the city with the smallest number of inhabitants throughout the observed period (Appendix 5).



Appendices 3 and 4. Number of inhabitants in the cities of Serbia according to the censuses in 1991 and 2002



Appendices 5. Number of inhabitants in the cities of Serbia according to the censuses in 2011

CONCLUSION

Cities on the territory of today's state of Serbia have existed from the Roman period. Over time, the significance of certain cities has changed in line with historical, political and social changes changing their hierarchy.

According to the Rank-size rule, Novi Sad, as the second city in the hierarchy, has three times smaller number of inhabitants than it should, and this is the biggest deviation. A similar situation occurs in other cities, where, according to the expected rank of size, cities in Serbia have considerably fewer inhabitants. Of the 26 cities analyzed, Vršac has the smallest difference between the expected and the actual number of inhabitants compared to the rank in the hierarchy.

During the analyzed censuses, urban primacy was constantly greater than 6, which highlights the difference between Belgrade and other cities in Serbia.

According to Schmook's method of determining the centrality of the settlements, the largest positive values of the active population employed in the tertiary and quaternary sectors were recorded for the largest cities (Novi Sad, Belgrade, Niš). The lowest negative values were recorded in Vranje, Šabac and Kruševac.

The cities that have according to the latest census over 150,000 residents are Novi Sad, Belgrade and Niš, which is less than in 2002, when this category included Kragujevac and Priština.

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