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Exploring the Contemporary Spatial and Temporary Dynamics of the Settlement Hierarchy and System in Serbia's Srem Region

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KEYWORDS

- settlement hierarchy
- settlement network
- primacy
- rank-size rule
- Srem
- Serbia

ABSTRACT

Newer trends of balanced regional development emphasize the development of functional integrational areas and strong spatial and functional relations based on the nodal concept and a functional process approach. Therefore, it is essential to determine the hierarchy of settlements in the network, which defines their demographic and functional capacity. This paper identifies the nature and characteristics of urban primacy in the Srem region in Serbia, using the rank-size rule and urban primacy index, as well as the hierarchy of settlements in the network, by calculating the importance of secondary activities and the centralization of the settlements. The results confirmed that while urban primacy is not expressed, the hierarchy of the settlements remains dominated by urban and suburban centres.

Introduction

In the modern world, no autonomous settlements or towns are independent of others. Some functions have become so important that they have outgrown the needs of the local population and have begun attracting residents of neighbouring settlements. Such settlements overtake their neighbours in development, size, importance, and standing in certain hierarchical relationships (Kaplan et al., 2014).

The settlement hierarchy means that influential spheres of functions in various cities do not have the same importance and reach and that the area they affect is called a gravitational sphere (Krugman, 1996). Settlement hierarchy and gravitational spheres are two main elements in the settlement system. The settlement system implies that all the settlements in a region, regardless of politics or natural criteria, are in some interdependent relationships (Ćurčić et al., 2021).

When studying the system of settlements in an area, a number of fundamental questions about the relationships between the individual towns and cities and their hinterlands need to be considered. Human settlements today are characterized by a complex structural and functional stratification reflected at many levels – from the typology of the built structures to the relationships and connections they form with each other. Contemporary settlement relations are marked by multi-layered spatial overlapping of urban and rural characteristics in particular areas and equal and reciprocal functional flows of people, capital, goods, information, and technological processes. Growing interdependencies between cities and other surround-

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ing settlements have been significantly transformed from traditional and straightforward one-way relationships to complex dynamic networks dominating various activities (Schaefer, 1977; Sennett, 1994).

Among the first significant theoretical and methodological papers addressing the interaction between urban and rural settlements is Kohl's (1841) model. Additional significant contributions to the further development of this idea were made by Auerbach (1913), Weber (1929), von Thünen (1930), Christaller (1933) and Lösch (1954). A significant contribution was made by Christaller (1933) with his much-respected theory of central places, where he connects the spatial distribution of centres with their essential functions, which supply the population with central goods and services. He assumed that the connections between the settlements are established in an idealized hexagonal pattern, on the principle that a small number of centres of higher rank supply a large number of centres of lower rank in close distances, ignoring the industry and the production function.

In his general theory, Friedmann (1972) points to urban systems as spatially organized unities. On the local and regional level, differences can be made between daily, weekly, and monthly urban systems (Berry, 1967; Friedmann, 1972). At higher levels of spatial aggregation, the urban systems can be considered national, sub-continental, continental, world or global in scope (Geyer, 2002). Castells (1993) distinguishes the difference between global networks and world systems – global networks cover the entire world, while world systems cover the subsets of global networks.

Furthermore, Castells (1994) writes about global cities as hubs and centres, hierarchically organized according to their relative importance in the network. Soja (2000) speaks about the urban revolution that brings many changes in the industry, such as flexible specialized industry, globalized urban regions, post-urban exopolises and "crumbled cities", which Giddens attributed to the westernization of the world and the western conditionality of globalization and its urban indicators (Giddens, 1995, 2002). Saskia Sassen (2001), the most profound analyst of the city's networks from a sociological point of view, also stands side by side with the aforementioned authors. She makes a difference between global and world cities, of which the former are in a network, while the latter do not have to be, but can be. World cities are the focal points of all their functions, while global cities belong to a group in which they must be in order to be global, that is, independent from the place.

According to the theory of the central places, the hierarchy of central places is developed as a result of the wide distribution of people who need goods and services. The term hierarchy of urban centres (Christaller, 1933; Lösch, 1954) is associated with the concept of an urban system and appears in much of the literature and is collectively referred to as the theory of location. This theory deals with factors that determine the location of social and economic activities in an area and the economies of agglomerations (Fujita et al., 1999; Parr, 2002a, 2002b; Malmberg & Maskell, 2002; Richardson, 1973) and which are one of the crucial factors in the manifestation of urban hierarchy. The individual nodes of the cities and their hinterlands are examples of nodal regions, which are the simplest features of the functional, social, and economic space.

Besides all the limitations mentioned above, the classical urban theories have served as spatial models for the planning of settlement networks and the development of areas that are under an immediate impact, as was the case in the south of Germany. They remain a part of planning practice, especially in environments where the hierarchical relationships in the spatial organization are clearly expressed and the interactions between the settlements in the system are less complex.

Recent research in settlement hierarchy explores various approaches to understanding how settlements are structured and categorized based on factors such as population density, economic activity, and geographic distribution (Lee, 2017; Budde & Neumann, 2019; Dobis et al., 2020; Bergs, 2021). In his recent study, Griffith (2022) updates the United States urban hierarchy by using spatial autocorrelation and other geospatial metrics to reveal patterns in settlement structures and their implications on regional development. He finds that geographic proximity and regional factors create coherent settlement groupings, which help define urban-rural distinctions and hierarchical layers within urban networks.

Moreover, Altaweel (2015) employs agent-based modelling to examine settlement dynamics, particularly how interactions between individual agents (people, goods, services) shape hierarchical settlement patterns over time. This modelling approach, grounded in entropy maximization, allows researchers to simulate and analyze changes in settlement hierarchies as influenced by migration and resource distribution patterns, offering a dynamic view of urbanization processes. Similarly, Chun and Kim (2022) investigate South Korea's urban structure evolution from the 1950s to the present, focusing on urban primacy and spatial interactions. They use population data and commuting patterns to assess urban connectivity and hierarchy, applying primacy and spatial interaction indices to analyze how urban areas interact.

Meanwhile, Sat (2018) examines whether Turkey's urban regions have shifted from monocentric to polycentric spatial structures using the Primacy Index and Rank-Size Rule. Recent studies on settlement hierarchy in Hungary concentrate on regional dynamics, particularly challenges in rural and urban development, economic disparities, and the effects of policy reforms on settlement networks. Bagyura (2020) analyzes the effects of suburbanization on power dynamics in municipal councils within Budapest's suburban areas, highlighting shifts in governance influenced by regional growth.

Additionally, recent research on settlement hierarchy in Romania addresses several key areas, including urbanization trends, regional development, and socio-spatial changes due to migration and economic shifts. A significant area of study is the transformation of settlement structures since Romania's post-socialist transition (Benedek, 2006; Mitrică et al., 2014), which altered urban-rural dynamics and population distribution (Lung, 2019). These studies reveal that cities with strong secondary and tertiary sectors, particularly those along major transport corridors, have remained economically resilient (Benedek, 2016). Furthermore, Horeczki et al. (2023) explore Romania's urban development, highlighting challenges and opportunities in its spatial planning and metropolitan growth. The authors argue for a balanced, polycentric urban development model that supports regional centres in fostering growth across the country rather than concentrating resources in Bucharest.

Lastly, Jošić and Žmuk (2020) adopt a novel approach, investigating whether Croatia's urban hierarchy can be approximated using the Fibonacci sequence, analyzing historical population data from 1857 to 2011. They apply two methods: one divides the largest city's population by the golden ratio, and the other applies the golden ratio iteratively to each successive city. Findings show that Croatia's urban hierarchy aligns well with the Fibonacci sequence, particularly when Zagreb is excluded due to its disproportionately large size. This study suggests that the Fibonacci sequence may be valuable for analyzing urban population systems, complementing existing urban economics theories like Zipf's and Gibrat's laws.

Partial approaches, both in territorial and thematic terms, are generally dominant in previous studies that have examined the networks and urban systems of Serbia. On the one hand, there are many studies of geographical networks and settlement systems in some parts of Serbia at a regional or administrative district/municipality level. Some research includes only network and settlement system segments, such as demographic features and functional characteristics. On the other hand, there are fewer territorial and thematically comprehensive studies of the network and the system of settlements. More recent studies of the hierarchy of settlements in Serbia are focused on urban settlements. Filipović et al. (2022) examine the functional dependence and demographic changes in the daily urban system of Belgrade during its post-socialist transition. They redefine commuting zones, observing shifts in functional dependence on the city core due to demographic changes, increased mobility, and shifts in economic centres, which call for strategic planning to manage this growth and dependency.

Meanwhile, Živanović et al. (2020) evaluate urban regions in Serbia, focusing on their functional polycentricity, or the presence and distribution of multiple urban centres within regions. The study assesses factors such as population concentration, employment distribution, and activity sectors across primary and secondary centres. Findings indicate that nearly half of Serbia's urban regions are monocentric, relying primarily on a single central hub, while a few, such as Novi Sad, exhibit greater polycentric characteristics. These polycentric regions benefit from multiple secondary centres that help disperse economic activity, promoting balanced regional development. Furthermore, the authors suggest that policies fostering decentralized growth and re-industrialization could strengthen secondary centres, ultimately achieving a more balanced national urban system.

In this regard, the purpose of this study is to evaluate the hierarchy and characteristics of the settlement network in the Srem settlement system, that is, a cross-section that exists at the beginning of the 21st century, in order to achieve a better understanding of the spatial and functional organization of this region.

The main question examined is what types of connections exist between settlements of all hierarchical levels and how these relationships affect the survival and future of the settlements in the Srem region in Serbia.

Methods

The research was conducted on the territory of the Srem region, which includes the municipalities of Inđija, Irig, Pećinci, Ruma, Sremska Mitrovica, Stara Pazova, and Šid (Figure 1). These municipalities encompass a total area of 3,671 km^2 and are inhabited by 312,278 people, distributed in 109 settlements (Krajić, 2013; Lukić et al., 2014; Đerčan et al., 2017a; Đerčan et al., 2022). The population data used are from the 2011 Census (Statistical Office of the Republic of Serbia, 2014) and the data on the population's activities from the Statistical Office of the Republic of Serbia.

There are different ways to determine the ranking of a settlement in the settlement hierarchy. Christaller (1960) opted for the "telephone method", where the degree of centrality was determined based on the number of telephone connections. Schmook (1968) took into account the population employed in some tertiary activities. Davies (1967) based thinking on a location coefficient and Preston (1975) based his on the value of retail sales, average earnings and share of household income spent on the purchase of goods and services. The Rank-size rule is also often used. It is

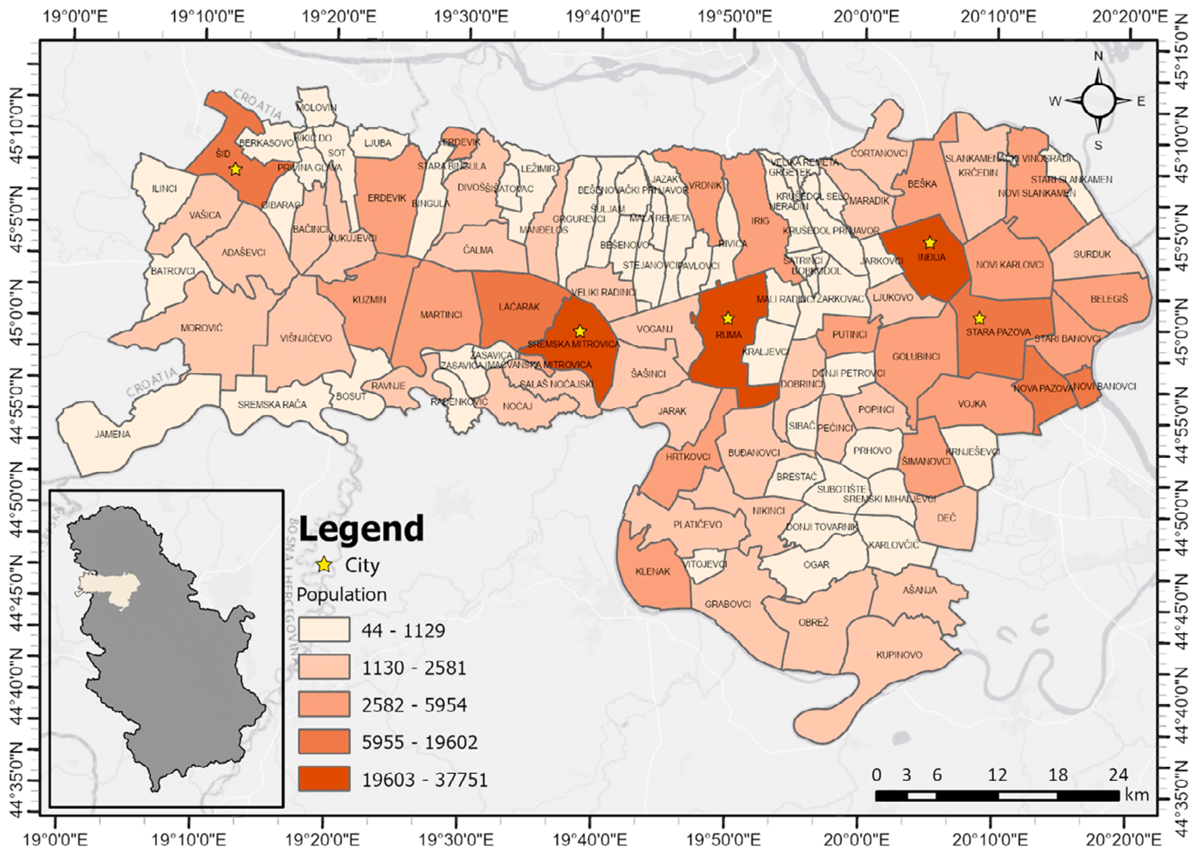

Figure 1. Study area

based on the assumption that the rank of the settlement in the hierarchy complies with its size compared to other places (Vresk, 2002).

Auerbach (1913) noted a specific correlation between the size and the number of cities and a tendency in the number and magnitude of towns in an area. This interdependence theory is formulated as a Rank-size rule, also known as the Zipf law, widely used in this kind of research (Alperovich, 1984, 1993; Guerin-Pace, 1995; Brakman et al., 1999; Gabaix, 1999; Ioannides & Overman, 2003, Soo, 2005; Córdoba, 2008). According to the Rank-size rule, it can be expected that one of the cities in a number of cities of a country or region, ordered by size, will have as many inhabitants as there are in the largest city divided by the number assigned (or ranked) to this city in a number of cities. Thus, the second largest settlement in the series will have half the largest population; the third will have a third and so on. Mathematically, this can be expressed as a formula:

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

Where S_n is the expected number of city inhabitants in the series, S_1 – is the population of the largest city and r – is the number of the city in the series.

Jefferson (1939) noted that urban systems often exhibit irregularities, especially regarding city sizes and ranks. He noted that in some countries, the capital, the primate city, stands out because of its size, while the other cities are much smaller. He called this phenomenon the "law of the primate city," explaining it by pointing out the capital city's exceptional political, economic, and social importance.

A simple formula calculates the Urban primacy index of a country or region:

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

Where I is the urban primacy index, G_1 is the largest city's population, and G_2 is the population of the second largest city. Urban primacy is more significant if the resulting index value exceeds 2. The urban primacy may be expressed by the ratio of the population of the largest city and the population of the following few largest cities in the series:

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

In practice the following three largest cities are most commonly used to calculate it as follows: $G_2 + G_3 + G_4$.

Quantitative methods determined the importance of secondary activities in the network of settlements. For this purpose, a modified Schmook's (1968) method applied to secondary activities has been used (Vresk, 2002). The results were obtained using this form:

$$ISA_1 = An\left(\frac{SCn}{An} - \frac{SCr}{Ar}\right)$$

Where: *An* –active population in the settlement, *SCn* –active population in the secondary sector of the settlement, *SCr* – active population in the secondary sector in the region, *Ar* – active population in the region.

In order to present the results of the importance of secondary activities graphically, a model derived from Rochefort's method for secondary activities was used (Rochefort 1957, 1959). The hierarchy of settlements using this method is obtained according to the following formulas:

$$X = \frac{SCn}{An}$$

$$Y = \frac{SCn}{SCr}$$

The meaning of the marks is the same as in the previous formula. *X* represents the abscissa, and *Y* is the ordinate in Figure 3.

The hierarchy of settlements by this method is obtained according to the following formula:

$$ISA_2 = \sqrt{X^2 + Y^2} \cdot 100 \cdot tg\frac{Y}{X}$$

Quantitative methods based on the active population in the tertiary–quaternary sector of the settlements were used to determine the centrality of the settlements.

One of the research methods for determining the level of development, location, and importance of the settlement in the network is Schmook's method. According to this method, centrality is calculated as the deviation of the share of the tertiary–quaternary sector in the active population in the settlement compared to the same average for the region. Centrality is calculated according to the following model:

$$C1 = An\left(\frac{TQn}{An} - \frac{TQr}{Ar}\right)$$

Where: *An* – active population in the settlement, *TQn* – active population in tertiary – quaternary sector of the settlement, *TQr* – active population in tertiary – quaternary sector in the region, and *Ar* – active population in the region.

Rochefort's method also provides a graphical representation of settlement centrality in the form of:

$$X = \frac{TQn}{Ar}$$

$$Y = \frac{TQn}{TQr}$$

Form markings have the same meanings as in Schmook's model, where *X* and *Y* are the abscissae, or ordinate, of the coordinate system.

The centrality of the settlement using Rochefort's model was obtained according to the formula:

$$C2 = \sqrt{X^2 + Y^2} \cdot 100 \cdot tg\frac{Y}{X}$$

For this study, ArcGIS Pro software was used to generate maps. The data used for the visualization and geospatial interpretation is derived from the Census of Population, Households and Dwellings in the Republic of Serbia.

Results and discussion

Over time, cities in a country develop a hierarchy. The expression of this hierarchy is the distribution of the size of a city's population that can easily be constructed for any urban system (Dimitrova & Ausloos, 2015). According to the Rank-size rule, the distribution of settlements is most commonly displayed by a graph with an arithmetic scale, so the function is in the form of a curve. If the sizes are expressed with a logarithm, then the graphic form of the order of magnitude will have a straight line. Rightness is clearly visible: There is always a small number of settlements with a larger population and a much larger number of settlements with a small population. The size increases as the size reduces the frequency of settlements with the same population. The distribution of settlements is shown in Figure 2.

However, Pearson's correlation coefficient ($r=.984$, $p=.000$ ($p<0.01$)) indicates that there is a robust positive correlation between the distribution of settlements according to the population size and the distribution of settlements according to the Rank-size rule.

The index of urban primacy was calculated by applying the Rank-size rule according to the aforementioned formulas. Based on the first statement (the ratio of Sremska Mitrovica and Ruma), the urban primacy index is 1.26. Based on the second statement (the ratio of Sremska Mitrovica on one side and settlements Ruma, Inđija and

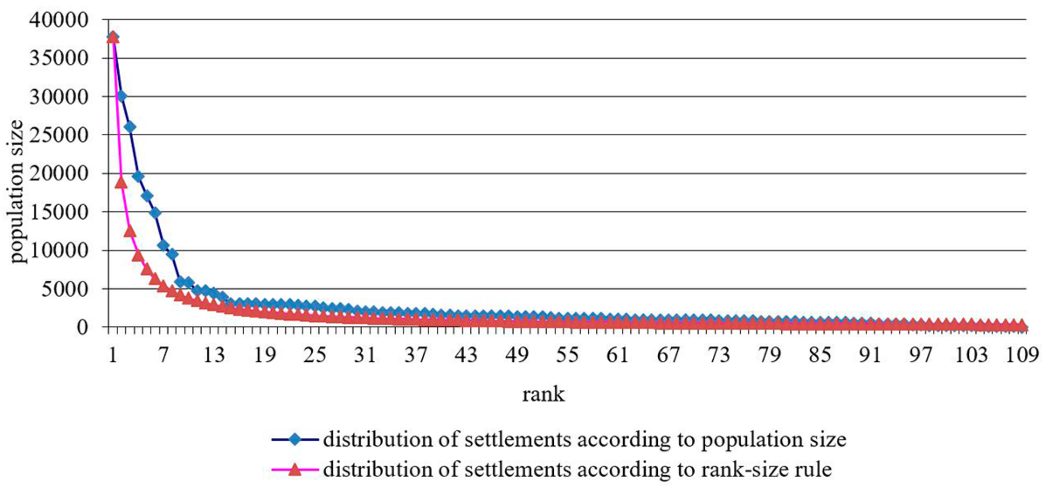

Figure 2. Comparative review of the distribution of settlements according to the population size and the rank-size rule in the Srem region

Stara Pazova on the other side), the urban primacy index is 0.50. In both cases, the value is less than 2, which means that the urban primacy of only one city is not prominent in the Srem region. Although it is the region's administrative centre, Sremska Mitrovica has only 7,000 more inhabitants than Ruma. In the same period, at the Republic of Serbia level, the urban primacy index (Belgrade-Novi Sad) was 4.86 (Đerčan et al., 2017b). The urban primacy phenomenon is even more pronounced in many developing countries. For example, the urban primacy index in Jammu and Kashmir (India) in 2011 was 7.9 (Yousuf & Shah, 2014).

Polèse and Denis-Jacob (2010) analyzed the evolution of city ranking at the top of national urban hierarchies in 74 countries during the 20th century. They found that European city ranking shows significantly fewer variations over time than in North and South America and developing countries. This finding aligns with the view that urban hierarchies become more stable and robust over time as the rural-urban transition is completed and settlement patterns mature. Changes in ranking at the top are rare, and where they do appear, they can be linked to political events that alter the direction of trade or the role of the city as a central place. The urban system of the Srem region is composed of small and medium-sized cities whose population sizes and ranking have not significantly varied over recent years, which is in line with the research carried out by Dimou and Schaffar (2009). They acknowledge that medium-sized cities are more resistant to external shocks caused by conflict, change of national borders and institutional turmoil than those with large agglomerations.

Secondary and tertiary quaternary activities are essential factors in determining the hierarchy in the network of settlements and generally give importance to settlements throughout the Srem region.

Secondary activities, primarily industry, contributed significantly to the growth and development of settlements and strengthened the differentiation in the network of settlements regarding influence. Industry attracts the population; it is the most important factor of urbanization and the driving factor of the polarizing effect of cities and centres in the area.

According to the derived Schmook's model, the importance of secondary activities is shown in Figure 4 (ISA 1). The highest level in the hierarchy of settlements according to the relative importance of secondary activities is Inđija, followed by Stara Pazova, Sremska Mitrovica, Ruma and Šid, all of which are municipal centres. Higher levels have suburbs like Nova Pazova, Laćarak, Vojka, Stari Banovci, Putinci and Mačvanska Mitrovica. It can be concluded that the settlements with relatively high importance of secondary activities are either municipal centres or suburban areas with a high share of daily commuters; together, they form some conurbation. Some previous studies have come to similar conclusions (Bole, 2004, 2011; Nared & Razpotnik Visković, 2016; Popović, 2020). Slovenian authors found that conurbations in Slovenia, defined basically on daily migrations, are more extensive and numerous than conurbations defined by complementary central functions. By adding daily migrants, these authors supported the established approach using complementary central functions, which set the definition of conurbations in broader contexts and point to possibly new directions in spatial development. The importance of secondary activities is shown graphically in Figure 3.

According to the results of this method, settlements with the highest importance are presented with the dots at a greater distance from the coordinate beginning and away from the abscissa and ordinate.

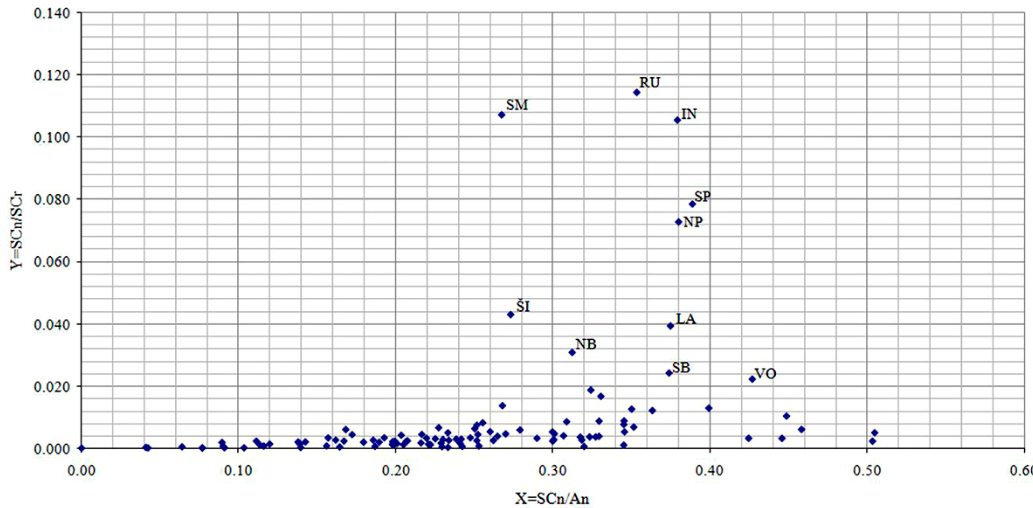

Figure 3. Secondary activities in settlements using the Rochefort'smethod
Legend: RU- Ruma, SM – Sremska Mitrovica, IN – Inđija, SP – Stara Pazova, NP – Nova Pazova, ŠI – Šid, LA – Laćarak, NB – Novi Banovci, SB – Stari Banovci, VO – Vojka

Figure 4 (ISA 2) shows the settlements with the most significant importance of secondary activities in the settlement network of the Srem region according to the modified Rochefort's model.

According to the second model, the changes in the hierarchy within the network of settlements are insignificant. According to Schmook's modified model, the settlements with a higher share of the secondary sector have a relative-

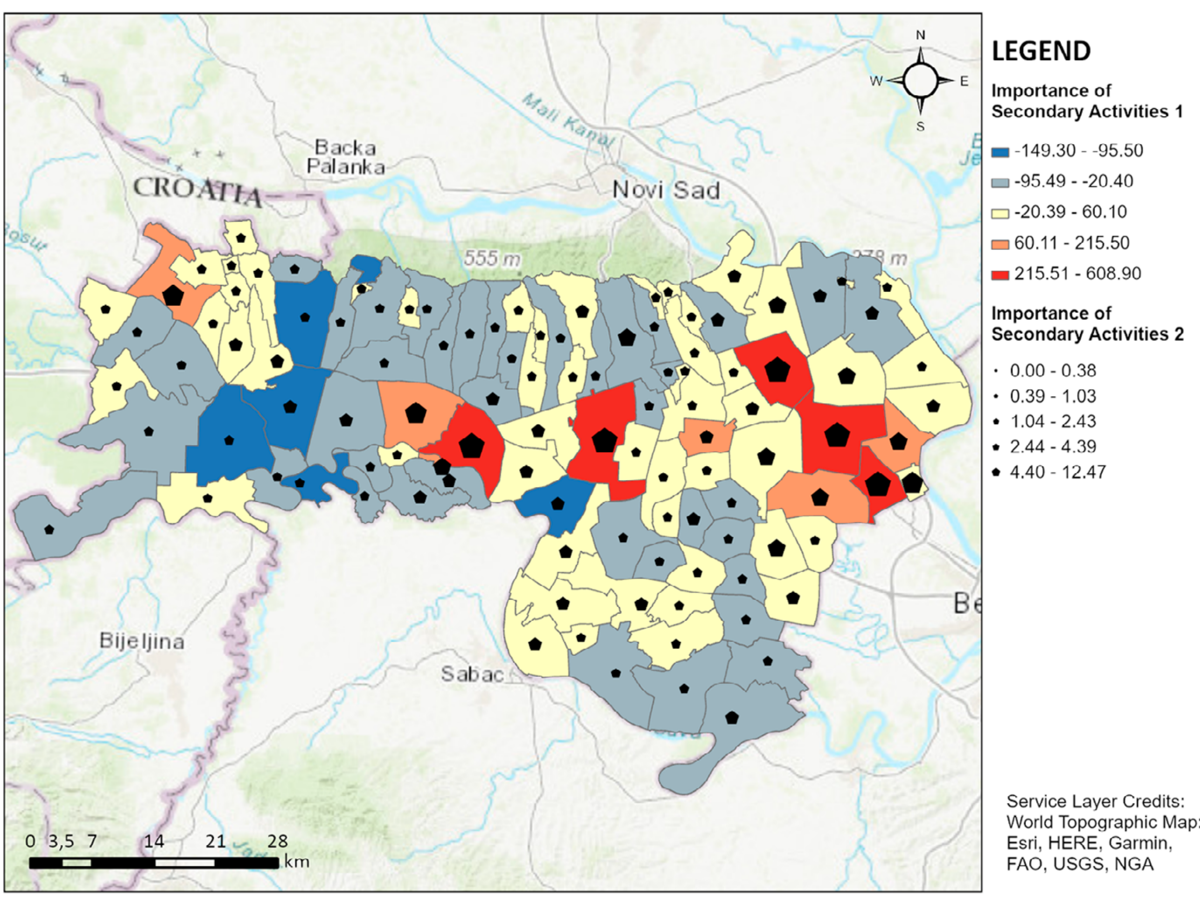

Figure 4. Comparative display of the importance of secondary activities according to the derived Schmook's and Rochefort's models

ly higher significance. In contrast, according to Rochefort's model, settlements with larger active populations in secondary activities have a higher significance.

The position of the settlement in the system or hierarchy is determined by the degree of its centrality. In this system, the higher-ranking cities are those that have a greater gravitational sphere, that has a more significant number of basic functions and those where the functions have more power. They also gather the lower-ranking cities with central importance because the population of smaller towns and their gravitational zones meet a part of their needs in large centres. The Slovenian authors make similar conclusions cited above using the combined index of the degree of centrality (Nared et al., 2017). If the centrality based on functions is greater than the centrality based on the number of inhabitants, the settlement is oversupplied, and if the opposite exists, the system is undersupplied. Undersupply is characteristic of settlements near major cities, which is a consequence of suburbanization. The conclusion is drawn that the competitiveness of the central settlements is moderately correlated with their population size and supply functions.

Sremska Mitrovica has the highest centrality, followed by Ruma, Šid, and Inđija. Among the 15 settlements with the highest centrality are all the municipal centres except Irig. Other settlements with high centrality are mainly suburban areas in the municipalities of Stara Pazova, Inđija, Pećinci and Sremska Mitrovica. According to Schmook's model, the centrality of settlements is shown in Figure 5 (C1).

Graphically presented values of settlements centrality are shown in Figure 6. Settlements at a greater distance from the coordinate system have a greater centrality. It is noted that this is Sremska Mitrovica, the seat of the region and the largest city in the Srem region. It is followed by municipal centres Ruma, Inđija, Stara Pazova and Šid. The municipal centresIrigand Pećinci are not among the settlements with greater centrality. Other settlements are the suburban towns Nova Pazova, Novi Banovci and Laćarak.

The results of Rochefort's model (Figure 5, C2) show that larger settlements have a higher place in the hierarchy of settlements in relation to Schmook's model, where the share of the tertiary–quaternary sector in the active population of the settlement had relatively high importance. However, these two models do not show any significant discrepancies. From this research, Sremska Mitrovica, Ruma, Inđija, Stara and Nova Pazova and Šid are the settlements with the highest centrality.

The results of the hierarchy of settlements in the Srem region according to the importance of secondary activities and centrality showed no significant differences. Municipal centres and their suburban areas are high in the hi-

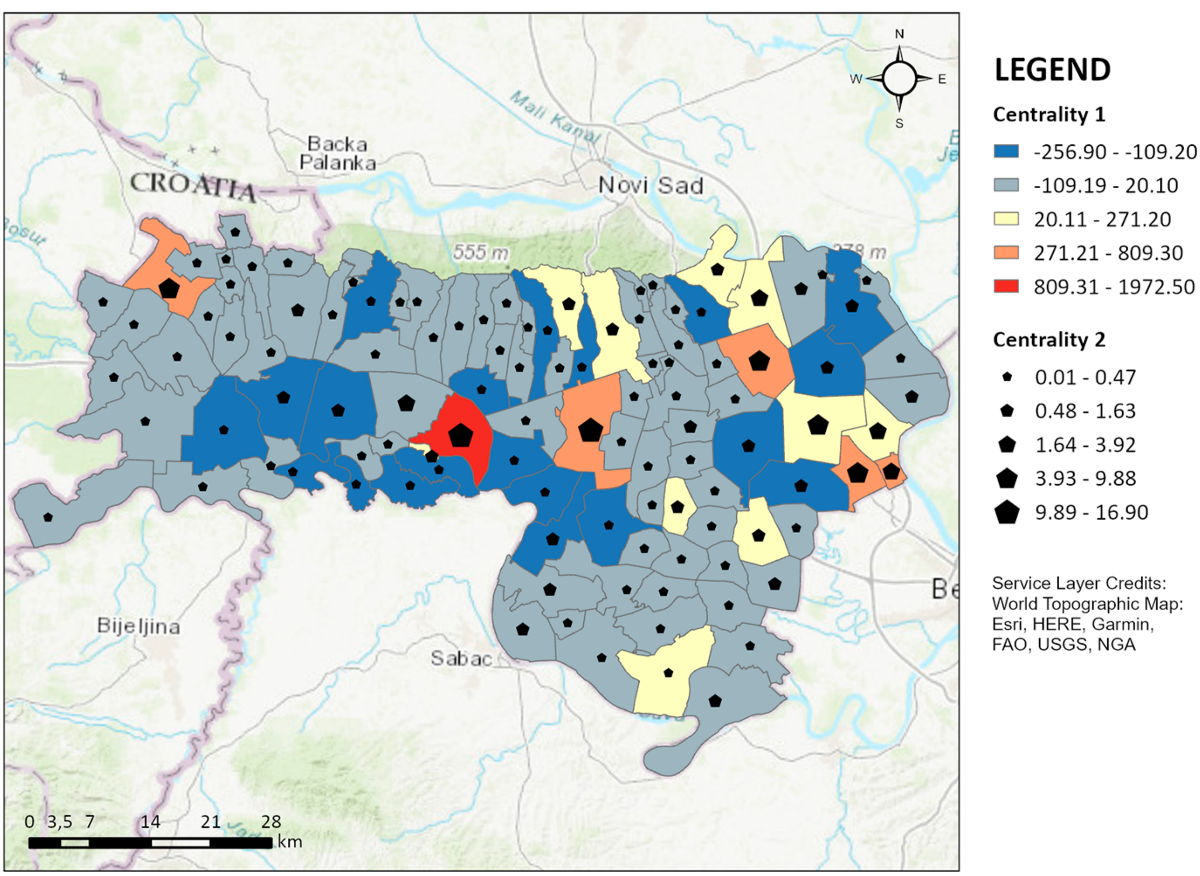

Figure 5. Comparative display of centrality according to the derived Schmook's and Rochefort's models

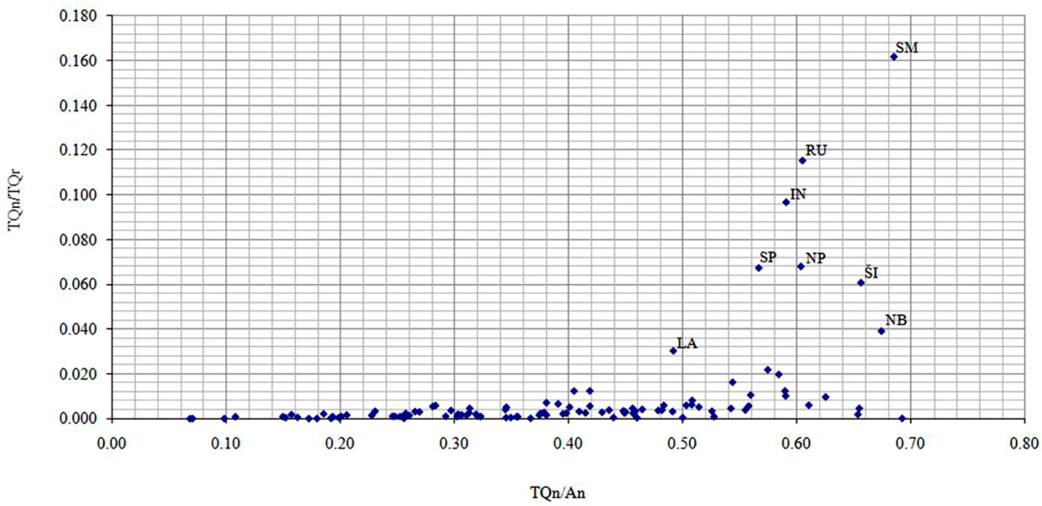

Figure 6. Settlement centrality according to Rochefort's method
Legend: SM – Sremska Mitrovica, RU- Ruma, IN – Inđija, SP – Stara Pazova, NP – Nova Pazova, ŠI – Šid, LA – Laćarak, NB – Novi Banovci.

erarchy sequence. Small, rural settlements, often peripherally located on Fruška Gora, occupy the bottom of the hierarchy of the settlements of the Srem region.

Based on previous research, the organization of the settlement network in the Srem region was defined using five levels:

1. Regional centre,
2. Sub-regional centre,
3. The municipal centre,
4. Local centre,
5. Village.

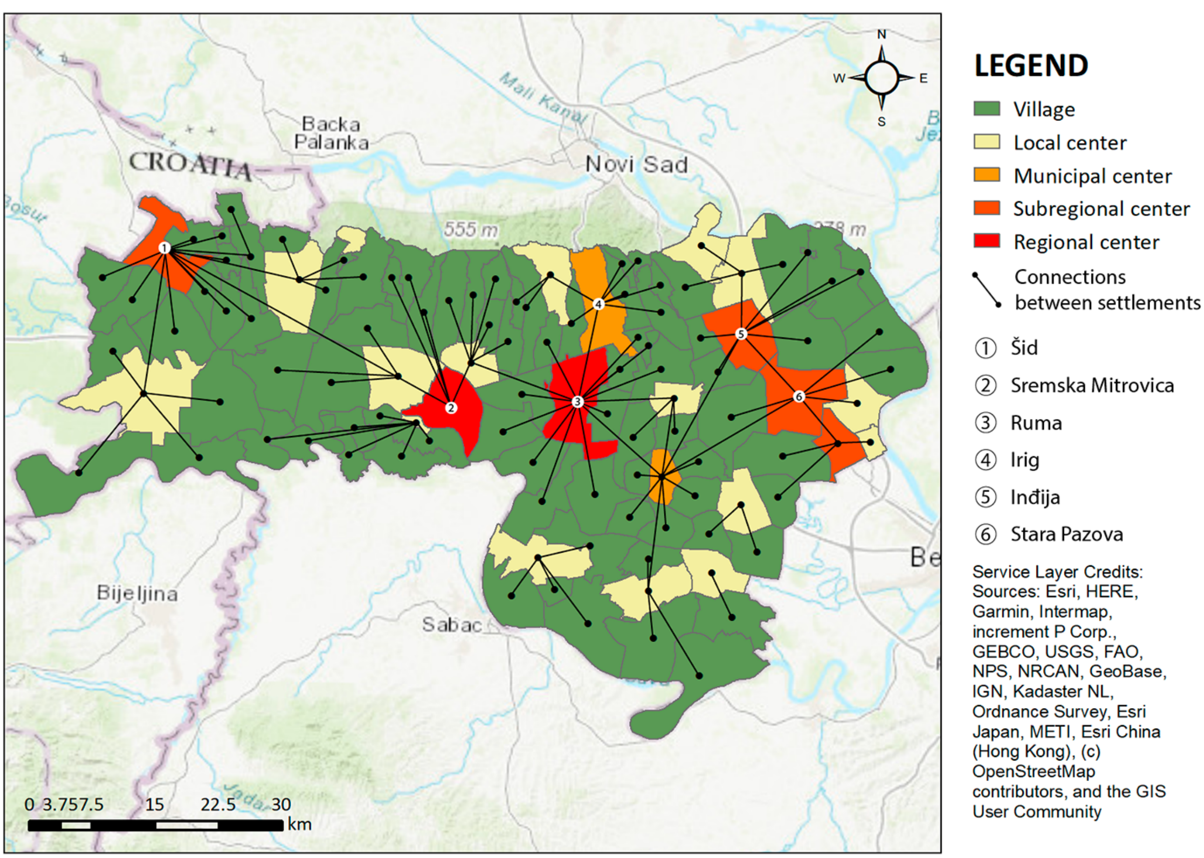

Figure 7. Organization of the settlements network in the Srem region

The criteria used to separate a regional from a sub-regional centre were the number of inhabitants, the value of centrality, the importance of secondary activities and the influential zone of the centre. The sub-regional centre has a smaller population and a lower zone of influence than the regional centre; also, it is linked to the regional centre by some tertiary–quaternary functions. Municipal centres have been identified based on already existing administrative divisions. The local centre is defined based on population, traffic position of the settlement on the municipal level and the type of the settlement according to the structure of activities. The village is one level that failed to meet the previous criteria. The organization of the settlement network is represented in Figure 7.

One of the processes expressed in this system of settlements is concentration. It is an expression of the polarizing effect of the centre and, therefore, is more prominent if the centre is more significant. In the Srem region, the concentration of activities, especially industry and population, is mainly in the eastern part. These are also the municipalities of StaraPazova and Inđija, which have the largest concentrations of economic activities and population; Sremska Mitrovica follows them as the region's centre and the largest city. The population is agglomerated alongside roads throughout the entire region. Congregating alongside the roads provides an opportunity for the development of small businesses and more accessible communication. On the other hand, in the northern and western parts of the region, there are areas where the number of inhabitants and functions in settlements decreases (Đerčan et al., 2017a). Previous regional policy ignored the development of a polycentric settlement system. The only way to avoid further concentration in spatial development is through some dispersion. As previous examples of good practice have shown, the resulting dispersion can have many positive effects on regional development (Kušar, 2013).

Conclusion

By applying the Law of the urban primary and calculating the index of urban primacy, this research has confirmed that urban primacy is not expressed in the Srem region. Sremska Mitrovica is the largest settlement in the Srem region, the administrative seat of the region, and the centre of educational and medical functions. However, the other settlements, primarily Ruma and Inđija, do not fall behind Sremska Mitrovica in population or number of functions. The proximity and relatively good connections with Belgrade and Novi Sad, which have a strong gravitational power, especially to the eastern part of the Srem region, should be considered. These results are in accord with contemporary development concepts, especially in EU countries where areas and regions should be considered and organized by principles that consider the temporal and spatial dynamic links based on the specific and active role of each settlement, not solely on the hierarchical relationship of dependency on the central city.

By analyzing the hierarchy of settlements in the network and calculating the importance of secondary activities and settlement centrality, it was confirmed that Sremska Mitrovica, Ruma, Inđija, Šid, Stara Pazova and Nova Pazova are the settlements that are at the top of the hierarchical ladder.

The analysis also confirms the flow of socio-geographic processes and structural changes in the settlement system, implying simultaneously the temporal and spatial dimensions. When considered as a whole, the Srem region's settlement system contains all forms of feedback effects and correlations of multiple relationships of interdependence.

The demographic, social and spatially functional relationships discussed in this study provide a framework for understanding a complex analysis, planning and directing system in a contemporary context and discussing system-wide development processes in a given space and time. The results represent a solid scientific framework that can be applied to all relevant state institutions and organizations at the local, regional, and national scales, as well as for adopting operational plans for developing strategies in a settlement system and network. Multiple connections between the settlements of all hierarchical levels provide opportunities for more effective use of the existing resources of the Srem region, both in the urban communities and rural areas. This would improve the living conditions for all and reduce the depopulation trends. Similar studies using the same methodology can be applied elsewhere.

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