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A HYPOTHESIS ON A COMPREHENSIVE APPROACH TO MANAGING THE URBAN POLYCENTRALIZATION OF POST-SOCIALIST METROPOLITAN AREAS

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Managing the polycentralization of metropolitan areas can contribute to a more even pace of development of built-up areas; it can also increase the economic and temporary accessibility of urban centers. This study, attempts to synthesize the main hypothetical provisions of a comprehensive approach to managing the development of polycentric metropolitan areas in post-socialist countries. It presents the necessity for modeling not only the core city, but also the entire metropolitan area when managing polycentralization. The study reveals the formalized stages of how a polycentric metropolitan area evolves and presents a comprehensive analysis on the main problems of a technological and methodological, administrative and legal nature in managing the development of polycentric metropolitan areas. It also highlights the significance of comprehensively developing the transport infrastructure and the prevalence of information and telecommunication technologies within the metropolitan area, as well as the spatial compactness of the metropolitan areas for the polycentralization progress. It is considered that the specific features of the post-socialist urban process can affect polycentralization, including (post-) suburbanization, reurbanization, and gentrification. Finally, measures are suggested in the field of scientific research and technologies, and municipal and regional management aimed at increasing the manageability of developing polycentric metropolitan areas in a post-socialist urban planning context.

Key words: **polycentric metropolitan area, sub-downtown, sub-center, satellite city, post-socialist urban planning.**

INTRODUCTION

A polycentric city emerges if there is more than one large urban center of social and business activity that has a significant societal and economic impact on the entire city and its metropolitan area. The polycentric city develops as an alternative to the monocentric one, in which there is only one large center of diverse public attraction and business activity. Usually it is a historical center, or downtown. The polycentralization of the city, as an optimization process in relation to the urban structure, can begin due to: its rapid spatial and population growth; a rise in commuting that becomes unacceptable in terms of its duration and speed of movement; and the stratification and development of the community. The development of urban polycentricity is an attempt to organize a more even, equitable distribution of space in the centers of social production and mass consumption within the urban area (Gaĭkova and Kiselëva, 2019), as well as to reduce the average time needed to reach public centers (downtowns, sub-downtowns).

Polycentric urban areas already exist objectively in developed countries. Polycentric development trends occur in many big cities around the world (Gaĭkova and Kiselëva, 2019) although with some exceptions, for instance, in Germany (Krehl, 2018). An interdisciplinary research area devoted to the problems of development and maintenance of urban polycentricity has arisen over recent decades. Many research papers from American, Chinese, European, Russian economists and economic geographers, specialists in the field of spatial planning, urban planners, architects, sociologists, mathematicians, etc., evidence this.

In the post-socialist countries of Eastern Europe and Russia, the problem of polycentric urban development is gaining relevance, with similar development scenarios in sub-centers (sub-downtowns). In spite of the notable amount of analytical research already carried out, there is still little

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evidence of much conceptual research aimed at synthesizing the basic features of polycentric urban development in post-socialist circumstances.

The purpose of the study is an attempt to develop a hypothesis about a strategy for the sustainable development of the large polycentric post-socialist city and its metropolitan area (with a population of more than 0.5 million people). The results may be useful in urban master-planning and even the architectural design of sub-downtowns.

A POLYCENTRIC CITY OR A POLYCENTRIC METROPOLITAN AREA?

It is important to study how influential state or regional spatial planning strategies are on urban polycentric development. What is the threshold scale of a territory under spatial development? And what is the most direct influence on intra-urban polycentralization?

Urbanization has affected almost all regions of the world today and continues to expand. In developed countries, urbanization has turned into "super-urbanization": the capital and largest cities of the continents grow and condense as a priority. Moreover, this development comes at the expense not only of rural settlements, but also of smaller second-tier cities (Shubenkov and Shubenkova, 2018; Bontje, 2007).

The "agglomeration effect" relevant today (Krasheninnikov, 2016) is based, from a spatial point of view, on the principle of clustering. Clusters are geographically localized voluntary associations of enterprises (Maslak *et al*., 2018) that provide either an industry, or mix-of-uses covering the needs of any inhabited territory, including the urban district or the city as a whole.

The trend towards the polarized shrinkage of urbanized territories has led to the development of metropolitan areas and larger populated urban realms, including conurbations, commercial (mega-) corridors and megalopolises (Gutnov and Lezhava, 1977; Lang *et al*., 2019, Nelson and Lang, 2018). With regard to an urbanized territory, the agglomeration principle (simplified, exchange between populated territories) and the clustering principle are, respectively, the functional and morphological sides of developing polarized urban structures. Such structures are based on pronounced dominant centers of public and financial attraction (Mazaev, 2019a), which ensures enhanced rates of economic growth of the parent territory as a whole. Thus, the comprehensive principle of spatially polarized development within urban territories is one of the basic characterizing features of future urbanization processes in the developed world.

However, the endless growth of the largest poles of resettlement systems is unprofitable from the point of view of equable spatial development on national and regional levels, and it can even lead to a violation of social justice in terms of the spatial availability of centers of public attraction. All of the above tend to increase the attention of researchers and policymakers towards better management of polarized resettlement systems (Mazaev, 2019a) through polycentralization, which can also arise spontaneously, probably as a latent social response to a trend in urban development, mostly in accordance with economic and production priorities.

The European concept of multilevel polycentrism includes all of the developing levels of spatial and urban planning, from the continental to intra-urban scale. However, there is no distinct evidence that managing polycentralization on the continental, national and inter-regional levels of spatial planning directly influences the spatial organization of emerging polycentricity at the intra-urban level (Pomorov and Zhukovsky, 2016b, 2019).

In the national and regional organization of polycentricity, the goal of authorities is a more *even* distribution of public goods and centers of attraction across cities. Cities are considered in such cases as a kind of "map dots", indifferent to their internal spatial structure, being monocentric or polycentric (Nordregio, 2005). The Japanese experience in the successive development of the polycentric Tokyo metropolitan area over many decades can additionally evidence this feature of spatial polycentricity (Sorensen, 2001).

Thus, it can be concluded that peculiarities under the planning consideration of megalopolises as a whole, mega-corridors and even conurbations are not of primary importance for determining the development strategy of intra-urban polycentrism from a spatial point of view. At the same time, the polycentric features of metropolitan areas with one dominant city would already significantly affect the polycentric development of the main city and its satellites.

It seems that it would be more correct to consider metropolitan areas, rather than just cities within their administrative boundaries, as the largest urban systems to experience manageable spatial polycentralization. This allows us to focus further research attention not only on the continuous urbanized territory of the main city, but also on satellite settlements involved in the daily exchange of labor and consumption with the main city. This concept is similar to the FUA (Functional Urban Areas) methodological approach, while managing European polycentrism (Antikainen, 2005).

Polycentric metropolitan area evolution model

The formation of a metropolitan area begins around one city with outpaced economic and population growth, which is determined by historical circumstances. (Figure 1, stages 0 and 1). As metropolitan areas form with a discrete or continuous nature, various forms of urban polycentricity may arise. These forms include polycentricity: within both the main and satellite cities (Figure 1, stage 2a, "discrete polycentric metropolitan area"); within the continuous urban area of the main city (Figure 1, stage 2b, "continuous polycentric metropolitan area"); with urban corridors connecting (sub-) centers of the main and satellite cities (Figure 1, stage 2c, "stellate polycentric metropolitan area").

At the highest level of development observed today, a composite polycentric metropolitan area may form, with both main and satellite cities comprising (sub-) centers of metropolitan significance, and even urban corridors between them (Figure 1, stage 3).

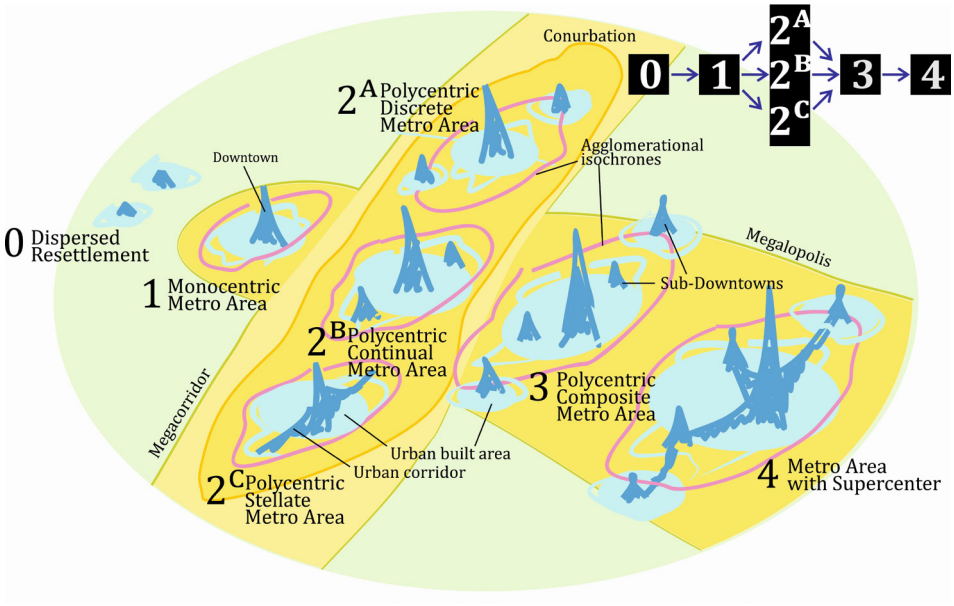

Figure 1. The stages of formation and evolution of a polycentric metropolitan area, in comparison with other urban systems under planning and management. The top-right scheme shows the prime options of evolution in stages

Hypothetically, at the highest level of development, a "supercenter" might form in a metropolitan area, if the literally morphological merging of urban centers and corridors lets a single lattice structure emergence (Zhukovsky and Pomorov, 2017) (Figure 1, stage 4).

The development of polycentric metropolitan areas involves not one, but a system of centrifugal clusters known as "urban center systems" (Gutnov, 1984), which determine the spatial distribution of jobs (Nasri *et al.*, 2018). The business and social functions of these centers are at the same time moderately self-sufficient and interdependent (Gaĭkova and Kiselëva, 2019; Kwon and Seo, 2018). The manageable development of metropolitan areas should involve special attention being paid to "human capital", and not only to economic and industrial features (Li͡ubovnyĭ, 2015).

Problems of the manageable development of polycentric polarized urban areas

Western European authors note improvements in the common understanding of implementing the goals of polycentrism by authorities and developers (Schmitt *et al.*, 2015). However, the foundations and targets of the concept are still vague. It is unclear who should act in implementing polycentrism and to what extent and sequence, while considering the intricate realm of interactions between various public and state institutions at all levels of management (Granqvista *et al.*, 2019). The ideological influence of the party in power on municipal urban policies (Savini, 2013) can further limit the intersubjective understanding of the polycentrism concept goals and objectives.

Another important professional problem of a methodological nature in the field of study is the delimitation of metropolitan areas with unambiguous administrative boundaries. Various approaches already exist, many of which deal with the boundaries of metropolitan areas as unstable and changing, depending on the density of daily commuting (Monastyrskai͡a and Peslyak, 2017).

When determining the conventional metropolitan area boundaries, one can rely on stable isochrone dynamics, as isochrones combine all points of a populated area with the average time of transport movement to the selected community (sub-) center. Russian scientists propose to determine boundaries of metropolitan areas by 2-hour isochrones and to include such boundaries in urban master plans, reviewable every 10 to 12 years (Li͡ubovnyĭ, 2015). However, then the contaminant problem of the robust detachment of metropolitan areas as municipal units or even as mini-regions arises.

Other methodological problems include the technological capabilities for monitoring the emergence and development of subcenters (Taubenböck *et al.*, 2011), and inventing multilevel approaches to assess the changing spatial structure of metropolitan areas (Nasri and Zhang, 2018), in particular, the dynamics of isochrones.

The manageable development of polycentric polarization, either in the European Union or within other world regions, shows the low productivity, or even the counter-productivity of strategies undertaken to achieve the goals of polycentrism, to equalize the development pace and opportunities for various inhabited areas.

Until now, it has not been obvious enough that the European polycentricity concept has a positive effect on forming a more even distribution of public goods across regions or entire countries (Maly, 2016). Polycentrism at the national level does not affect the distribution of public services by region, especially the unique facilities of culture (to mention the unlikely possibility of sustaining a "theater in the village" (Rauhut *et al.*, 2018). However, there is some evidence that the polycentrism concept leads to a more even distribution of offices by regions (Chen *et al.*, 2019). The compatibility of the "Sustainable City" and "Affordable City" concepts is

problematic, while polycentrism involves financial cost in a paradigm of sustainable urban development (Pagliarin, 2013).

At the level of metropolitan areas, the implementation of the polycentrism concept can enhance the significance of the old capitals and main regional cities, while secondary cities, and even satellites, would not be among the societal and economic beneficiaries (Verkhovykh, 2018; Tosics and Berescu, 2011). According to the intermediate results of the modern European policy of polycentrism, it is not possible to find confirmation of comparable support levels for the development of first-tier and second-tier cities within metropolitan areas or regions (Cardoso and Meijers, 2017). Even the development of transport corridors between cities leads to an increase in resource flows towards the primary cities of metropolitan areas (Zhong *et al*., 2015). For instance, Russian scientists recognize as undesirable the concept of developing nationwide resettlement systems based only on 20 state-selected metropolitan areas, as this will cause a massive drain of financial, infrastructural and human resources from inhabited territories outside these metropolitan areas (Bokov, 2018; Lîubovnyĭ, 2015; Skryabin, 2019).

Thus, as first-tier cities exploit smaller second-tier ones, the latter need to develop their own competitive advantages, even pooling resources together with other satellites. However, areas with low-density and dispersed urban resettlement without any form of polarization remain problematic too, as there is no dominant city to consolidate investments and increase the pace of the inhabited territory's development as a whole (Cardoso and Meijers, 2017).

Attempts to manage the development of metropolitan areas have an ambiguous effect on satellite urban centers and on satellite towns as a whole. To compare in terms of possible development rate, even more centralized and directive Chinese policies include paying primary attention to developing free economic zones. This leads to the strong prevalence of morphological polycentricity over what is functional, and very significant dominance of primary cities over outside-inhabited areas (Mu and Yeh, 2016).

The development of Chinese urban polycentrism was peculiar because developers bought cheaper land in the suburbs and began new building campaigns since they were more profitable in comparison with development or redevelopment in the existing (sub-) centers, even with the already provided urban infrastructure. As a result, large-scale alternative centers or areas with other functional purposes have arisen very quickly, but the environmental, functional and informational ties with the rest of the city and with the old centers have not matured as quickly.

A.V. Bokov mentions the same kind of practices among Russian planning authorities that are still widespread, whereby the view of "what ought to be built" takes priority over providing opportunities for commuting and the functional exchange between built areas (Bokov, 2018). Thus, examples of ghost developments in Soviet Tobol'sk (Tumanik, 2014) and even the ghost towns of Ordos and Tianducheng (Pomorov and Zhukovsky, 2019) confirm the desirability of analyzing and planning potential functional exchange between the centers in a developing polycentric metropolitan area (Wenze *et al*., 2019; Liu *et al*., 2016).

We should not overestimate planning itself as having a dominant influence on the process of polycentralization, because the spontaneous formation of new metropolitan (sub-) centers also takes place (Bontje, 2007; Olsvold, 2018). This fact supports the vision of the essence of urban planning as "influence" rather than "ruling" (Shubenkov, 2017; Shubenkov and Shubenkova, 2018). For instance, municipalities should be set up for equal and productive interaction with top urban developers, whose plans for erecting commercial real estate by all legal means is an indispensable factor of urban planning (Pomorov and Zhukovsky, 2016b).

Ways to solve the problems of satellite cities developing within metropolitan areas

The centers of satellite cities in metropolitan areas are subcenters of a discrete polycentric urban area. Consequently, the satellite cities' development level and their exchange context will affect the development of their centers. Regional authorities and municipalities can partially solve the main problem of an unbalanced exchange between first-tier and second-tier cities in favor of the former by taking the measures below:

- The search for the real competitive advantages of satellites within metropolitan areas, which can be expressed in terms of their proximity to large natural areas, the provision of specialized and innovative services and infrastructure like university campuses, tourism and medical camps and motels (Bokov, 2018; Tzaninis, 2015);
- Promoting the lifestyle in small satellite towns to erase the inherited socialist mental perception of a large city as obviously more attractive than a small one (Bokov, 2018);
- Investing in the development of second-tier metropolitan areas of smaller regional cities (Bokov, 2018; Lîubovnyĭ, 2015; Skryabin, 2019), bearing in mind that they would never develop as rapidly as the old first-tier metropolitan areas (Mazaev, 2019b); and
- Detailing the municipal guidance of urban planning by differentiating the indicators and standards imputed to be reached by large cities, small towns, suburbs, and villages. Target indicators cannot be unjustifiably equal for different settlement types (Bokov, 2018).

HOW DOES POLYCENTRALIZATION AFFECT A METROPOLITAN AREA AT THE INTRA-URBAN SPATIAL LEVEL?

Density, speed, features of traffic

The effect of spatial polycentricity and compactness on traffic congestion is ambiguous: in some cases negative, in others positive (Li *et al*., 2019). A variety of local facilities and businesses reduces the volume of forced trips (Duarte and Fernández, 2017).

For the largest cities, polycentrism is effective: it reduces the total level of traffic congestion (Li *et al*., 2019). However, a relatively excessive number of alternative centers can lead to "chaotic" traffic in the city and an increase in traffic congestion (Pomorov and Zhukovsky, 2016a).

Polycentralization contributes to the development of diversity in the choice of transport (Nasri *et al*., 2018). The emergence of additional (sub-) centers contributes to an increase in traffic flows, and the introduction of new transport communications leads to an increase in the total amount of intra-urban vehicles (Saprykina *et al*., 2019). A local increase in the level of education and income among the residents of a region (neighborhood) increases their mobility, and hence, the amount they commute (Shubenkov, 2017; Solis *et al*., 2019).

Distances and travel times

In Denmark, under the implementation of the polycentrism concept, travel distances decreased and the intensity of trips at the inter-urban level increased, while the latter decreased at the intra-urban level (Grunfelder *et al.*, 2015). In Luxembourg, the transport accessibility of public facilities increased by 9% after the transfer of some services from centers to subcenters (Decoville and Klein, 2020).

The local jobs-housing balance significantly affects the average movement time of transport in the city (Lin *et al*., 2019; Trujillo and Muñiz, 2014). This feature indirectly justifies the observed existence of a hybrid city model with many "non-centers" in addition to subcenters.

City economic performance

According to some reports, the consolidation of subcenters increases the economic efficiency of the city as a whole (Yingcheng, 2020). Subcenters create small positive extremes on a graph showing the relation between a decrease in land prices and the distance from the main center, but the global trend of decreasing prices is not affected (Huang *et al.*, 2018; Lang, 2003). Polycentric cities experience less property segregation than monocentric cities (Garcia-López and Moreno-Monroy, 2018).

FACTORS AFFECTING THE DEVELOPMENT OF POLYCENTRIC METROPOLITAN AREAS

One of the main factors contributing to the polycentralization of metropolitan areas is the development of a general transport infrastructure (Li *et al*., 2018; Li͡apunova and Platonova, 2017).

The introduction of advanced transportation allows the isochrones in the metropolitan area to expand to 1.5…2 hours, with the longest possible daily trips of 100 or more kilometers (Krasheninnikov, 2016). This effect also takes place within mega-corridor resettlement systems (Tolmachëva and Anti͡ufeeva, 2019).

Clear transport communications should be provided between the centers, since the level of social attractiveness of the center depends on its connectedness with other centers and the "buffer" areas: residential, industrial and reserved natural milieus (Liu *et al*., 2019; Sarkar *et al.*, 2018; Wenze *et al*., 2019). However, authorities should pay attention not only to the major transportation links between centers, but also to more even development of the transport infrastructure throughout the city, as well as within the "buffer" areas (Sarkar *et al*., 2018). Thus, transport must be accessible from both centers and "non-centers" throughout the metropolitan area (Li͡apunova and Platonova, 2017).

The development of transport infrastructure should correlate with planning new centers and monitoring their development, since underestimating the scale and pace of the spontaneous consolidation of unplanned "invisible" subcenters can lead to an increase in traffic congestion (Li͡apunova and Platonova, 2017; Sorensen, 2001) and gentrification throughout the city (Yang *et al*., 2015; Zhukovsky, 2018).

Subcenters are more likely to appear or remain when the time spent on various trips, the financial costs of traveling downtown and the purchase of land are less than staying downtown; the income associated with the local agglomeration effect would also cover the re-location costs (Harris and Ullman, 1945; Li͡apunova and Platonova, 2017). At the same time, the availability of the Internet improves the economic efficiency of a polycentric city (Zhang *et al*., 2017), although it also causes a decrease in the importance of traditional public urban spaces (Kuznetsova, 2013).

The development of information and telecommunication technologies affects the traffic in the city (Aguilera and Boutueil, 2018), reducing the need for mandatory clustering of public and business facilities literally within a neighborhood or block. This may explain the growing number of "non-central" areas of business activity and consumption (Krehl and Siedentop, 2018).

The compactness and continuity of urban areas (Dewita, 2018; Li *et al*., 2018) and the high density of urban development (Li and Liu, 2018) positively affect the usefulness of polycentralization to accomplish the aims of sustainable ecological development in the metropolitan area (Moiseev, 2017) and the creation of a more just urban structure in terms of the accessibility of the centers.

ADDITIONAL FEATURES OF POST-SOCIALIST URBAN DEVELOPMENT THAT CAN AFFECT POLYCENTRALIZATION

Suburbanization and gentrification

Gentrification in post-socialist cities occurs in the inner built-up areas and inner suburbs (Drozda, 2019; Grabkowska, 2012; Sýkora, 1999), parallel with the reurbanization process (Šimon *et al*., 2015), including the "revival" of the historical inner cities in Eastern Europe under revitalization and diversification (Grabkowska, 2012). The municipal regulation of urban development itself may also lead to gentrification (Chelsea, 2006).

Although gentrification within Russian metropolitan areas has not been a rising trend so far, they are experiencing specific changes on their peripheries. For instance, rural residents tend to move to high-rise neighborhoods (microrayons) (Hochstenbach and Musterd, 2017; Ouředníček, 2007); and developers organize residential quarters and shopping centers on former brownfields (Verkhovykh, 2018). The residents of rural areas and suburbs also have a need for additional inter-settlement sub-downtowns on exit routes with a mix of uses representing trade, medicine and leisure (Filanova and Kruglova, 2019).

Thus, the initial post-suburbanization already develops before suburbanization has become significant: still a small percentage of households currently live in low-density suburban settlements (Brade, 2012). To note, in Polish cities post-suburbanization has already come quite a long way, as new linear sub-centers of business and public activity in the form of sub-downtowns have already formed along the outbound routes.

In Western countries, the establishment of new satellite towns is often accompanied by suburbanization, for instance in Almere near Amsterdam, the Netherlands (Boterman and Tzaninis, 2018). The factors leading to the displacement of citizens to the suburbs and satellites include improving the well-being of households, and the efficient branding of satellite cities by municipalities and developers (Tzaninis, 2016).

The reverse process, reurbanization, which is the return of the population from the suburbs to the main city, often leads to gentrification. In this phase, young families with a need for a "central urban" lifestyle with pedestrian accessibility to a mix of urban uses (Grabkowska, 2012), higher-income people and foreign immigrants (Ouředníček, 2007), Tzaninis, 2015) move downtown.

Administrative issues

There is a need for planning and monitoring the polycentralization of each specific metropolitan area, taking into account the priority ranking of urban areas in order to stimulate them with forming or developing additional subcenters or sub-downtowns (Zhukovsky, 2018).

However, the municipalities in post-socialist countries still have little authority and are limited in funding and sources of income. A number of researchers note that the decentralization and expansion of municipal powers and budgets for the implementation of many urban development programs is needed (Bokov, 2018; Vogler, 2020). It is not necessary to create a "supra-municipality", but to intensify cooperation in the urban zoning of municipal and regional authorities, where the regions should regulate the relatively equal development pace within metropolitan areas (Marques *et al*., 2019, Smol'i͡aninov, 2018).

Post-socialist urban planners need to search for new forms of administrating urban development more flexibly (Tosics and Berescu, 2011). In particular, this means the transition from direct general planning with long-range forecasting (20 to 25 years) to masterplans in which spatial development is projected with granularity at the level of districts and centers, for a medium term of 10 to 12 years (Li͡ubovnyĭ, 2015).

Another administrative problem in post-socialist countries that impedes the controlled development of polycentric metropolitan areas, as exemplified by Russia, is the lack of a legal concept of a metropolitan area in the state urban planning codes (Verkhovykh, 2018). It is possible to design metropolitan areas as separate entities of the state, which may require a reform of the administrative division of regions or the state as a whole (Smol'i͡aninov, 2018).

There is also no single subject of planning in metropolitan areas, even in conditions of cooperation between various urban municipalities (Verkhovykh, 2018). From this point of view, the formation of a supra-municipal planning institute would be advisable.

DISCUSSION

A survey on the manageable development of polycentric metropolitan areas in post-socialist countries revealed the following details:

- Urbanization in developed countries, as well as in the post-socialist region, will continue to develop as "super-urbanization", implying the formation of polarized resettlement systems, including polycentric ones.
- The aim of stimulating urban polycentrism within polarization is to equalize the development possibilities and the pace concerning differing populated areas; it is also to increase the distance and time availability of (sub-) centers. For example, the authorities at different levels implement the polycentrism concept in the European Union today.
- Planners and authorities should manage the development of polycentrism concerning not just the cities within administrative boundaries but also the metropolitan areas as a whole. Thus, the downtowns of satellite cities are the sub-downtowns of metropolitan areas.
- The evolution of large-scale urban systems towards polycentricity, such as megalopolises, corridors and conurbations, does not directly affect the spatial aspects of polycentralization at the level of metropolitan areas.
- Monocentric metropolitan areas can transform during their evolution into different types of polycentric areas: continual, discrete, with a stellate configuration of the center, and discrete-continual (composite) with the prospect of integrating a single lattice-like "supercenter".
- The main factors affecting the features of polycentralization of metropolitan areas are:

  a) Comprehensive development of an urban transport infrastructure;

  b) Compactness and continuity of the urban territory;

  c) Suburbanization and reurbanization with the possible dominance of one of these at a time; and

  d) Mass introduction of information and telecommunication technologies.

- The main issues concerning the manageable polycentric development of metropolitan areas in post-socialist countries are:

  a) Unequal development opportunities and pace between the first-tier and the second-tier cities, their centers and respective metropolitan areas;

  b) Use of a directive "morphological" approach to forming alternative centers of urban attraction as a simple large-scale development, without enough consideration given to the emerging functional links between such a development and the rest of the metropolitan area;

  c) The ambiguous interpretation of the goals and objectives of polycentrism by various participants in urban planning;

d) The complicated nature of the operational and legal delimitation of metropolitan areas as objects of planning and management;

e) Lack of a legal concept of a "metropolitan area" in regional urban planning;

f) Limited financial, regulatory and research capabilities of municipalities; and

g) Technological and methodological problems of developing scientifically based models for regularly monitoring the evolution of polycentric metropolitan areas.

- Hypothesizing, those who take part in the manageable development of polycentric metropolitan areas in post-socialist countries should apply the following to achieve better societal and economic urban performance according to goals of the polycentrism concept:

  a) Legal designation of "Metropolitan Areas" and "Sub-Centers" with additional "Sub-Downtown" concepts in urban planning practice;

  b) Implementation of scientifically based delimitation of metropolitan areas and (sub-) centers with regularly updated isochrones and other necessary boundaries;

  c) Introduction of scientific and legal definitions of the "Polycentric Metropolitan Area" concept;

  d) Expansion of measures undertaken to make satellite cities and the main city rim more competitive and attractive;

  e) More differentiation of development goals (containment, expansion, stabilization) concerning various settlements and (sub-) centers in a polycentric metropolitan area, including attention to districts requiring urban renewal;

  f) Regular monitoring of suburbanization, reurbanization and gentrification processes within metropolitan areas;

  g) Regular monitoring of the efficiency of the metropolitan transport infrastructure according to the dynamics of changes in traffic volumes, average speed of movement, and the average time and distance of established pendulum migrations between (sub-) centers and residential zones;

  h) The introduction of more mathematical, graphic and analytical models to monitor the development of metropolitan areas, especially in provincial regions;

  i) Transition from a directive Soviet-style "general city plan" to a master plan of metropolitan areas with a medium-term prospect of planning aimed at neighborhood-scale urban areas, including the (sub-) centers;

  j) More even transport infrastructure development within and outside the (sub-) centers, also the introduction of advanced, flexible forms of public transport;

  k) Support for spatial consolidation of metropolitan areas through new development and revitalization practices; and

  l) Deepening further interdisciplinary research in relation to polycentric metropolitan areas in post-socialist countries, whilst providing the exchange of scientific and practical experience in the field.

CONCLUSION

Summarizing the above, a hypothesis has been put forward for a comprehensive strategy for the sustainable development of large polycentric metropolitan areas in post-socialist countries. This strategy should have, in theory, a robust interdisciplinary scientific approach, including urban concepts with spatial delimitations and monitoring. In practice, this strategy should not use a directive, but a differentiated approach to the development of real estate and transport, aimed at morphological and functional urban consolidation.

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