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METHODS AND APPROACHES OF DETERMINING THE BOUNDARIES OF AGGLOMERATIONS (BASIC CASE KHARKIV REGION)

Changes in social relations in Ukraine, its transition to a post-industrial society, structural changes in regional development lead in modern conditions to changes in the territorial organization of society, which directly affects the trends of regional development. The highest form of territorial organization of society are agglomerations – urban agglomerations. Defining the boundaries of agglomerations is an important step in the process of studying agglomerations and managing regional development, because it is necessary to clearly understand the territory to which the administrative influence should extend and the number of city councils whose activities should be coordinated in implementing regional policy. The purpose of this work is to analyze the existing methods, approaches and techniques for determining the boundaries of agglomerations, development of an algorithm for establishing the boundaries of agglomerations and its testing on the materials of the Kharkiv region.

The main theoretical and methodological starting points of delimitation of agglomeration boundaries are presented, approaches, methods and techniques, their quantitative and qualitative criteria, indicators, etc. are determined. The author's algorithm for establishing agglomeration boundaries is substantiated, initial positions, key indicators, coefficients and indices are indicated. The proposed algorithm was tested on the materials of Kharkiv region. It is established that the Kharkiv agglomeration is monocentric and well formed. The development coefficient of the Kharkiv urban agglomeration is 30.7, the agglomeration coefficient is 0.13, the agglomeration index is 0.25, which confirms the high level of development of this agglomeration and the significant polarizing effect of the city of Kharkiv. The applied indicators of concentration and population density, transport accessibility, allowed to establish that the Kharkiv agglomeration has a powerful organizational center of development - the city of Kharkiv, the polarizing effect of which is more pronounced in two districts – Kharkiv and Dergachiv, which form the central zone of the agglomeration. The center of the agglomeration is connected with remote centers of peripheral areas by radial-radial connections by transport and other types of connections, which forms an external zone consisting of Bohodukhiv, Valkiv, Vovchansk, Zmiiv, Zolochiv, Novovodolazk, Pecheneg and Chuhuiv districts. Based on the study, based on the principle of superposition, the author's vision of delimitation of the Kharkiv agglomeration in 2019 is presented. The zone of influence of organizational functions of the center extends to a radius of 70 km, but there are significant territorial disparities in the center and periphery.

The city of Kharkiv assumes most of the functions: administrative, economic, social, infrastructural and recreational, which to some extent hinders the development of small towns that are part of the agglomeration. The strengths of the Kharkiv agglomeration are indicated, as well as the priority directions of development are singled out. Given that the Kharkiv agglomeration is monocentric, and within it, as in the region there is a sharp uneven development of the center and periphery, effective management and addressing the hypertrophied development of the city, spatial planning and infrastructure development will alleviate this situation and facilitate the transition of the region. to the polycentric model of spatial organization, respectively, and the reduction of territorial disparities in the level and quality of life of the population of the Kharkiv region.

Keywords: agglomeration, delimitation, coefficients and indices of agglomeration, superposition principle, settlement system, regional development, Kharkiv region, Ukraine.

Катерина Кравченко, Костянтин Немець, Катерина Сегіда, Людмила Немець, Ольга Сунтелю. МЕТОДИ ТА ПІДХОДИ ДО ВИЗНАЧЕННЯ МЕЖ АГЛОМЕРАЦІЙ (НА ПРИКЛАДІ ХАРКІВСЬКОЇ ОБЛАСТІ)

Зміна суспільних відносин в Україні, її перехід до постіндустріального суспільства, структурні зрушення у регіональному розвитку призводять в сучасних умовах до змін у територіальній організації суспільства, що безпосередньо впливає на тенденції регіонального розвитку. Найвищою формою територіальної організації суспільства є агломераційні утворення – міські агломерації, визначення меж яких є важливим етапом у процесі дослідження агломераційних утворень та управління регіональним розвитком. Адже необхідно чітко усвідомлювати особливості території, на яку повинен поширюватись управлінський вплив, та кількість міськрад, діяльність яких необхідно узгоджувати при реалізації регіональної політики, спрямованої на комплексний розвиток певної територіальної одиниці. Метою роботи є аналіз існуючих методів, підходів та методик для визначення меж агломерацій, розробка алгоритму встановлення її меж та його апробація на матеріалах Харківської області.

Представлено основні теоретичні та методичні вихідні положення делімітації меж агломерацій, визначено підходи, методи та методики, їхні кількісні та якісні критерії, показники тощо. Обґрунтовано авторський алгоритм встановлення меж агломерації, зазначено вихідні положення, ключові показники, коефіцієнти та індекси. Запропонований алгоритм апробовано на матеріалах Харківської області. Встановлено, що Харківська агломерація є моноцентричною та достатньо добре сформованою. Коефіцієнт розвиненості Харківської міської агломерації складає 30,7, коефіцієнт агломеративності – 0,13, індекс агломеративності – 0,25, що підтверджує високий рівень розвитку даної агломерації та значну поляризуючу дію міста Харків. Застосовані показники концентрації та густоти розселення населення, транспортної доступності, дозволили встановити, що Харківська агломерація має потужний організаційний центр розвитку – місто Харків, поляризуюча дія якого у більшій мірі проявляється в двох районах – Харківському та Дергачівському, які і формують центральну зону агломерації. Радіально-променевими зв'язками центр агломерації сполучається і з віддаленими центрами периферійних районів транспортним та іншими видами зв'язків, що і формує зовнішню зону у складі Богодухівського, Валківського, Вовчанського, Зміївського, Золочівського, Нововодолазького, Печенізького та Чугуївського районів. На основі проведеного дослідження, виходячи із принципу суперпозиції, представлено авторське бачення делімітації меж Харківської агломерації у 2019 р. Зона впливу організаційних функцій центру розповсюджується на радіус 70 км, але існують значні територіальні диспропорції розвитку центра та периферії агломерації.

Місто Харків перетягує на себе більшість функцій: управлінську, економічну, соціальну, інфраструктурну та рекреаційну, що певною мірою стримує розвиток малих міст, що входять до агломерації. Зазначені сильні сторони Харківської агломерації, а також виокремлені пріоритетні напрями розвитку. З огляду на те, що Харківська агломерація є моноцентричною, і в її межах, як і в області, прослідковується різка нерівномірність розвитку центра та периферії, ефективне управління та вирішення питань гіпертрофованого розвитку міста, планування території та інфраструктурного розвитку дозволить знівелювати дану ситуацію та сприяти переходу області до поліцентричної моделі просторової організації, відповідно й зменшення територіальних диспропорцій рівня та якості життя населення Харківського регіону.

Ключові слова: агломерація, делімітація, коефіцієнти та індекси агломеративності, принцип суперпозиції, система розселення, регіональний розвиток, Харківська область, Україна.

Екатерина Кравченко, Константин Немец, Екатерина Сегиды, Людмила Немец, Ольга Сунтелю. МЕТОДЫ И ПОДХОДЫ К ОПРЕДЕЛЕНИЮ ГРАНИЦ АГЛОМЕРАЦИЙ (НА ПРИМЕРЕ ХАРЬКОВСКОЙ ОБЛАСТИ)

Изменение общественных отношений в Украине, ее переход к постиндустриальному обществу, структурные сдвиги в региональном развитии приводят в современных условиях к изменениям в территориальной организации общества, что непосредственно влияет на тенденции регионального развития. Высшей формой территориальной организации общества является агломерационные образования – городские агломерации, определение границ которых является важным этапом в процессе исследования агломерационных образований и управлении региональным развитием. Ведь необходимо четко осознавать особенности территории, на которую должно распространяться управляющее воздействие, и количество горсоветов, деятельность которых необходимо согласовывать при реализации региональной политики, направленной на комплексное развитие определенной территориальной единицы. Целью работы является анализ существующих методов, подходов и методик для определения границ агломераций, разработка алгоритма установления границ агломерации и его апробация на материалах Харьковской области.

Представлены основные теоретические и методические исходные положения делимитации границ агломераций, определены подходы, методы и методики, их количественные и качественные критерии, показатели и тому подобное. Обоснован авторский алгоритм установления границ агломерации, определены исходные положения, ключевые показатели, коэффициенты и индексы. Предложенный алгоритм апробирован на материалах Харьковской области. Установлено, что Харьковская агломерация является моноцентрической и достаточно хорошо сформированной. Коэффициент развитости Харьковской городской агломерации составляет 30,7, коэффициент агломеративности – 0,13, индекс агломеративности – 0,25, что подтверждает высокий уровень развития данной агломерации и значительное поляризующее действие города Харькова. Примененные показатели концентрации и плотности расселения населения, транспортной доступности позволили установить, что Харьковская агломерация имеет мощный организационный центр развития – город Харьков, поляризирующее действие которого в большей степени проявляется в двух районах – Харьковском и Дергачевском, которые и формируют центральную зону агломерации. Радиально-лучевыми связями центр агломерации сочетается и с удаленными центрами периферийных районов транспортным и другими видами связей, и формирует внешнюю зону в составе Богодуховского,

Валковського, Волчанського, Змієвського, Золочевського, Нововодолажського, Печенежського і Чугуєвського районів. На основі проведеного дослідження, виходячи з принципу суперпозиції, представлено авторське бачення делімітації границь Харківської агломерації в 2019 році. Зона впливу організаційних функцій центра розповсюджується на радіус 70 км, але існують значительні територіальні диспропорції розвитку центра і периферії агломерації.

Місто Харків перетягує на себе більшість функцій: управлінську, економічну, соціальну, інфраструктурну і рекреаційну, що в певній ступені здержує розвиток малих міст, що входять в агломерацію. Вказані сильні сторони Харківської агломерації, а також виділені пріоритетні напрямки розвитку. Враховуючи те, що Харківська агломерація є моноцентричною, і в її межах, як і в області, простежується різка нерівномірність розвитку центра і периферії, ефективне управління і рішення питань гіпертрофованого розвитку міста, планування території і інфраструктурного розвитку дозволить нивелювати даний стан і сприяти переходу області до поліцентричної моделі просторової організації, відповідно і зменшення територіальних диспропорцій рівня і якості життя населення Харківського регіону.

Ключові слова: агломерація, делімітація, коефіцієнти і індекси агломеративності, принцип суперпозиції, система розселення, регіональний розвиток, Харківська область, Україна.

Problem definition. Contemporary socio-geographical research aims at a comprehensive analysis of the object of study in order to determine the optimal opportunities for its development. When studying the current state of development of the region and forecasting its further evolution, it is extremely important to identify the features of the territorial organization of society, which directly affects the state and trends of economic development of the region. Territorial organization of the population is differentiated by different forms of settlement: settlement systems, isolated settlements and more. However, the higher the level of territorial organization of the population, the usually more successful is the development of the territory, because the settlement of the population is influenced by the historical features of the region, the resource potential of the territory and so on.

The highest form of territorial organization of society are agglomerations – urban agglomerations. Agglomerations are formed directly in those areas where the level of self-organization of the settlement system is extremely high, there is a clearly defined center (or several), there is a high level of economic development, there is a strong transport network. In Ukraine, the largest agglomerations of the same name are located in Kyiv, Kharkiv, Dnipropetrovsk and Odesa regions. All four regions are distinguished by the above features. However, the presence of agglomeration is not a guarantee of further intensive development of the region, but indicates the economic capacity of the region in the past and present.

Despite their synergistic nature, for further evolution, agglomerations must be moderately controlled, that is, to act as an object of municipal government. However, it is extremely difficult to determine the boundaries of the agglomeration in most cases, as the organizing influence of the center may extend far beyond the suburban area or first-level neighboring areas. Thus, defining the boundaries of the agglomeration is an important step in the study of agglomerations and management of regional development, because it is necessary to clearly understand the territory to which the administrative influence and the number of city councils, whose activities must be coordinated in implementing regional policy units.

Analysis of previous research. Defining the boundaries of the agglomeration is important for creating

a strategy for its development, implementation of management decisions, the study of socio-economic, infrastructural and environmental issues. Also, the delimitation of the agglomeration is important for its spatial and statistical analysis, study of territorial structure and assessment of quantitative indicators (such as population, index of concentration of production, etc.).

The issue of delimitation of agglomeration formations is revealed in the works of many domestic and foreign researchers. In particular, *Rosenthal S. Stuart and Strange C. William* propose to establish boundaries based on the Ellison-Glaeser index, to calculate the level of spatial concentration among industries at the county or state level. The Ellison-Glaeser index depends on both the geographical distribution of employment and the intra-industrial distribution of employment to institutions. The authors focus on the three micro-foundations of the agglomeration that were most common in the theoretical literature: surplus knowledge, labor market integration, and investment exchange [17].

Bolshakov V. [3] offers a method that consists of three main stages:

- determination of the main municipalities with the help of population data (identification of urban areas, or so-called "urban clusters of high density" in the study region) (the study takes place without taking into account the administrative-territorial division);
- inclusion of adjacent territories belonging to the same functional urban zone, as it is established that urban settlement cores have an organizing influence;
- definition of deep areas (suburban areas) bordering on densely populated municipalities are united around urban nuclei. The final stage of implementation of the methodology is to determine the deep areas of agglomerations (suburban areas) [3]

Morphological and functional approaches are used to measure the spatial structure of *Skadins T.* settlement systems. The most significant difference of opinion in the academic discussion is to establish a starting point for determining the boundaries of the urban agglomeration: only functional or only morphological aspects of the settlement system, whether to use their combination [4].

The morphological approach is mostly based on the urban spatial structure, defined as a built-up environment in terms of land use. Therefore, spatial data is key to this approach. It can also be defined as a statistical or quantitative perspective. Population density is also

regularly used. General population measurements are also important for both the main part and the whole agglomeration. Migration indicators (eg net migration) were also used. Transport accessibility has always been an important morphological indicator in agglomeration studies. This is somewhat at odds with the approaches of other researchers, in which the distance to the routes is mainly used as a functional indicator. Instead, the *functional approach* is based on different socio-economic characteristics of the settlement, which analyzes the functional relationships within a particular management system. This approach is used more often than morphological, and because socio-economic data are incredibly important, many studies use different social and economic (active) indicators and their thresholds [20]. These can be indicators of GDP, number of jobs, incomes, information on taxes and more. However, depending on the individual characteristics of a country's development, the thresholds may change. All suburban routes and the motivation of their existence (pendulum migration to work or leisure) are taken into account in the analysis of transport infrastructure. Time availability is extremely important and depends on the specific indicators set in the selected country. The main highways, which connect settlements of different levels of subordination and rural areas with the main city or other lower-ranking cities, are given the most attention [18].

Klaassen's L. model is popular in the study of agglomerations. He identifies four stages of agglomeration: кількість населення ядра збільшується за рахунок периферії;

- the population of the periphery is growing faster than the core;
- the population of the nucleus is declining faster than the population of the periphery;
- the population of the nucleus resumes population growth or loses population more slowly than the periphery.

The model is based solely on the dynamics of the population of the core city and the periphery, it does not take into account the functional aspects of agglomerations – internal connections [8].

Garreau J. proposes the concept of Edge Cities, which is based on the "growth points" of the agglomeration, ie settlements of the periphery, which are gradually evolving into local subcenters and may compete with the core city in the future. The concept considers the settlement aspect, concentration on the agglomeration periphery of economic, social, business, recreational and other functions [5].

Lappo G. identifies the following groups of criteria for delimitation of urban agglomerations:

- criteria for the size of the core (population, number of jobs in the central city);
- criteria for the development of the outer zone (population of the suburban zone, the urban population of the suburban zone);
- the number of urban settlements in the suburban area, the share of those employed in agriculture);
- parameters of connections between the core and the outer zone (the share of the population of the

suburban zone working in the center, the temporary accessibility of the central city);

- integrated criteria that characterize the agglomeration as a whole (population density, development of urban agglomeration, etc.);
- criteria for allocating the boundaries of an urban agglomeration on the basis of determining its spatial or temporal radius, fixing the size of the territory within which the agglomeration has developed or is developing. [9].

Pivovarov Yu. identifies areas of influence of all cities with a population of over 50 thousand people. The next step is to combine the zones of influence of adjacent cities, if the distance between them does not exceed 25 km, regardless of the population of these cities, and the number of adjacent cities is at least three [16].

Lozynsky R. and Kostyuk I. consider the method of isochronous accessibility to the center of the agglomeration to be a sufficiently representative method of allocating agglomerations. Usually build isochrons 0.5, 1, 1.5, 2 hours of availability. Accordingly, different access zones are distinguished from the core of the agglomeration. It is believed that the agglomeration may include settlements within one and a half hours of accessibility to the core of the agglomeration, or two hours, taking into account the cost of time at the final and intermediate stops. Moreover, the average speed of transport is as follows: 35 km – on roads of interstate importance, 30 - national, 25 – regional, 20 – local. However, scholars unequivocally agree that isochrons of accessibility reflect the likelihood of connections between settlements rather than real connections. Therefore, this technique is a tool for delimitation of "possible agglomeration areas" [10]. Therefore, transport accessibility within the two branches is an important indicator of determining the boundaries of the agglomeration. However, it should be noted that in the case when the studied settlement system does not meet these conditions, but has a direction in this direction, it is classified as a "potential urban agglomeration" [14].

In domestic scientific practice, *three groups of criteria* are most often used when selecting the boundaries of an urban agglomeration:

- population density in urban agglomerations should be significantly higher than the average population density in the country, region or district;
- the distances between cities, respectively, and the time required to overcome them, in the agglomeration should be much less than the distances typical of the whole country, region or district;
- indicators of the intensity of relationships between settlements, the degree of their cooperation in production processes, services and communications, labor and cultural movements should significantly exceed similar averages in the country, region or district [2; 21]

The criterion of population density is considered the main among the above. The population density of one thousand people per square kilometer is considered critical.

The criterion of the intensity of the relationship between settlements is also one of the main in

determining the boundaries of the agglomeration. The main condition for the development of an urban agglomeration is the intensive interaction of settlements included in this agglomeration. At the initial stage of development of the agglomeration there are processes of integration, ie the formation of unified systems of development of the territory, which go beyond the administrative boundaries of settlements. Integration processes are manifested in various areas: demographic (growth of intensity and diversity of migration within the agglomeration), labor market (formation of a single labor market, increasing the number of jobs), transport (formation of a single transport system and transport infrastructure), utilities, social sphere, information, cultural and recreational, etc.

The isochron method is a common method of dividing the boundaries of an urban agglomeration. The method involves determining the boundaries of the agglomeration by the time required to travel to the center of the agglomeration and is based on the selection of the so-called ends around the core of the agglomeration.

The boundaries of the agglomeration are usually outside the agglomeration core and have a specific radial shape that encompasses other settlement nuclei. Cities of the agglomeration are characterized by strong connections: industrial, labor, transport, infrastructure, recreation with the settlements of the agglomeration, as well as with external settlements, which excludes the possibility of their autonomous analysis as part of the agglomeration [14].

Labor migrations that are pendulum-oriented and directed to the agglomeration center or other large cities of the agglomeration, which in turn causes a decrease in the rural population that migrates to the city in search of work and decent wages are characterized by high intensity and frequency [22].

The method of delimitation of agglomeration boundaries is not established, and differs in many countries. In European countries, it is customary to determine the outer boundary of the agglomeration based on the completion of continuous urban development. In Anglo-America, agglomerations are formal: so-called "agglomeration governments" are formed, but the agglomeration itself does not have administrative-territorial status [21].

There are some problems in the management of territories in cases where the boundaries of the agglomeration do not coincide with the administrative-territorial boundaries. For example, in France, the boundaries of agglomerations are set by law [6].

In fact, the boundaries of agglomerations are determined according to the difference of statistical indicators by the respective categories. It should be noted that in the Kharkiv region there is no centralized accounting of indicators that would comprehensively characterize the agglomerations, and most of the available scientific achievements are fragmented and do not give a comprehensive idea of the current development of agglomerations in the region. In this paper we present an algorithm for determining the boundaries of the agglomeration based on a combination of certain methods, techniques and approaches.

The purpose of this research is to analyze existing methods, approaches and techniques for determining the boundaries of agglomerations, the development of an algorithm for establishing the boundaries of agglomerations and its testing on the materials of the Kharkiv region.

Presentation of research results. An effective method of determining the boundaries of the agglomeration is the method of IFI-modeling, based on the concept of "zone of influence" of the socio-geographical object [12; 13]. According to this method, agglomerations are isolated by analyzing the intersection of zones of influence of different settlements, which is identified by the integrated function of influence (IFI). At the same time, it is possible to analyze different levels of generalization of the IFI-surface for different socio-geographical and demographic parameters, which gives much more information about the relationships between objects within the agglomerations [12; 13].

In this work, an attempt is made to allocate agglomerations on the basis of the following indicators:

- population size and density;
- similar nature of demographic processes;
- the method of isolines (in particular – isochrons, which allow you to track the time spent moving to the sinter center);
- the presence of suburbs and suburban areas.

Delimitation of the boundaries of the urban agglomeration requires a scientifically sound approach and a comprehensive assessment of many parameters. However, given the dynamism of such systems, their boundaries are quite difficult to define clearly.

Usually, the study of urban agglomeration is carried out using mathematical calculations that allow to determine its features and certain parameters: the coefficient of development of urban agglomeration, the coefficient of agglomeration and the agglomeration index (table 1).

Calculate the main indicators that characterize the Kharkiv agglomeration, namely, the coefficient of development of the urban agglomeration, the coefficient of agglomeration and the agglomeration index.

The coefficient of development of the urban agglomeration allows to investigate the level of development of the agglomeration on the basis of the urban population of the agglomeration, the number of urban settlements and the ratio of their population. Calculate this coefficient by formula 1.

$$K_{dev} = P * (M * m + N * n) = \\ = 1915445 * (12 * 86,7 + 44 * 13,3) = \mathbf{30,7}$$

This indicator should be $\geq 1,0$. The coefficient of development of the urban agglomeration of the Kharkiv agglomeration is equal to 30.7, which corresponds to the established parameters, the agglomeration is very developed. This indicator indicates a significant level of development of the Kharkiv agglomeration, which is due to the retrospective features of its formation, the organizing influence of the regional center.

Table 1

Formulas for calculating agglomeration coefficients

(created by the authors according to [9; 16])

Formula	Parameters	
Coefficient of development of urban agglomeration		
$K_{dev} = P * (M * m + N * n)$	K_{dev} – coefficient of development of agglomeration, P – the number of urban population of the agglomeration (million people), M, N – the number of cities and towns, respectively, m, n – their shares in the urban population of the agglomeration, respectively, $\geq 1,0$.	(1)
Coefficient of agglomeration		
$K_a = \left(\frac{N}{S}\right) * R$	K – coefficient of agglomeration, N – the number of urban settlements in the agglomeration, S – the size of the agglomeration, R – the average distance between urban settlements of the agglomeration, $>0,1$	(2)
Agglomeration index		
$I_a = \frac{P}{P_a}$	I – agglomeration index, P – population of the satellite area, Pa – the number of urban population of the agglomeration, $>0,1$	(3)

The agglomeration coefficient allows to determine the level of formation of the studied agglomeration on the basis of the number of urban settlements that are part of the agglomeration, the area of the agglomeration, and the average distance between urban settlements that are within the agglomeration. This indicator must be greater than > 0.1 . Measurements of distance between urban settlements of Kharkiv region were carried out in Google Map (average distance is about 42 km.). Calculate the coefficient by formula 2.

$$K_a = \left(\frac{N}{S}\right) * R = \left(\frac{56}{17146,5}\right) * 42 = 0,13$$

For the Kharkiv agglomeration, the agglomeration coefficient is equal to 0.13, which means the classification of the agglomeration as *promising*.

The agglomeration index is calculated on the basis of the ratio of the population of the satellite zone and the total population of the agglomeration, ie excluding the agglomeration core. The specified index value must be greater than > 0.1 .

$$I_a = \frac{P}{P_a} = \frac{469338}{1915445} = 0,25$$

For the Kharkiv region, the agglomeration index is 0.25, which means the intensive development of the Kharkiv agglomeration. Thus, the calculations prove that the Kharkiv agglomeration is developed and well formed. The core of the agglomeration has strong organizational properties.

Consider forming Kharkiv agglomeration using IFI-modeling. In our study, IFI modeling was performed on time sections: 1959 (Fig. 1.a) and 2019 (Fig. 1.b).

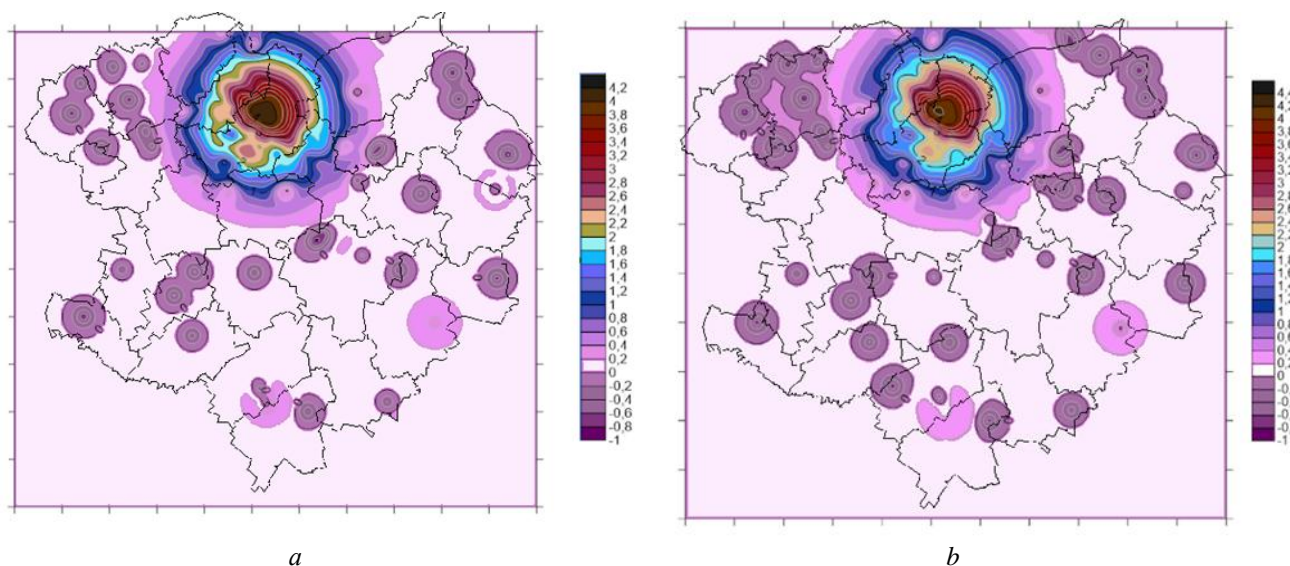


Fig. 1. Models of the IFI surface of the settlement of Kharkiv region in 1959 (a) and 2019 (c), $R0=10$ km
(constructed by the authors according to [7])

The development of the Kharkiv agglomeration is representatively demonstrated in Fig. 1. Also, the polarizing effect is observed not only in the city of Kharkiv, but also in the city of Merefa. The 2019 model traces certain elongated zones of influence of organizational nuclei of settlement. Thus, the disparities in development are presented directly within the zone of influence of the Kharkiv region, the phenomenon of population concentration in cities as "growth centers" of the region.

Regarding the configuration of the Kharkiv agglomeration, which is determined by the development of the city-center (or centers in the case of polycentric agglomeration or conurbation), one of the outstanding

criteria for its development should be considered the population size and density. As a rule, the polarizing influence of the center, in many respects, determines the development of areas close to it and forms certain "axes" of development (Fig. 1 a, b).

Given the uneven distribution of the population of Kharkiv region on the territory use the method of interpolation to determine the nuclei of settlement, semi-periphery and peripheral areas (Fig. 2 a). The interpolation of the population of Kharkiv region showed that the main nuclei of the region's settlement are the city of Kharkiv, cities of regional significance (Izyum, Lozova, Pervomaisky, Chuhuiv, Kupyansk), and district centers.

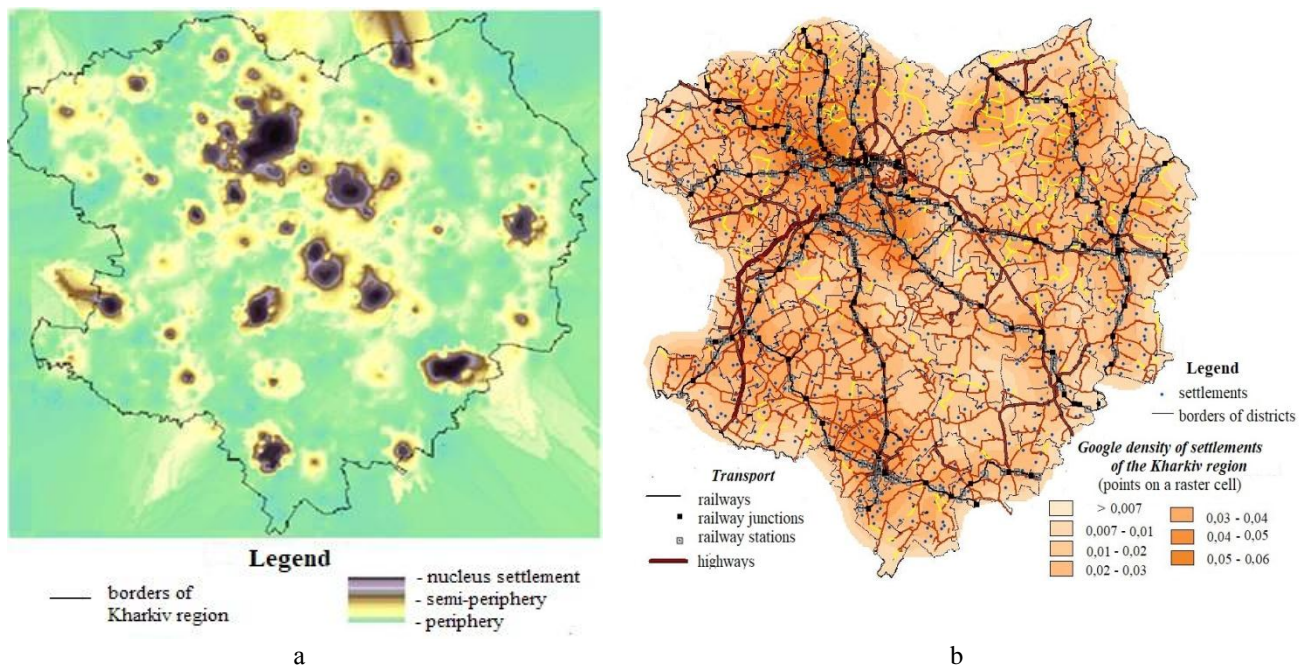


Fig. 2. Population (a) and population density (b) in the region (created by the authors according to [7])

There is a significant organizing influence of the nucleus of settlement – the city of Kharkiv and in fact you can see the Kharkiv urban agglomeration, which is oriented in the boundaries of districts in Chuhuiv and Kharkiv districts, respectively. Regarding the population density (Fig. 2 b), in accordance with the location of the settlement nuclei formed the meridional axis of settlement – the highest density of settlement is characterized by the regional center and cities of regional importance - among the districts – the center.

The next factor in determining the boundaries of the agglomeration is the level of development of the transport network (Fig. 3).

According to the basic framework of settlement of the region, the transport network (both rail and road transport) has a radial-circular shape. The transport network has the highest density in Kharkiv and Chuhuiv districts, which are also characterized by a high population and a significant population density. The city of Kharkiv is a multifunctional transport hub, and connects Kharkiv region with its first-class neighbors, provides connections of the region with the CIS

countries. The international road connection of the region is provided by highways: Kyiv-Kharkiv-Dovzhansky, Kharkiv-Dnipro-Zaporizhzhya, Kharkiv-Goptivka, and Kharkiv-Krasnograd-Pereshchepyno.

An important issue in the study of agglomerations is the transport accessibility of district centers, which largely determines the degree of development of the agglomeration. Kharkiv and Chuhuiv districts and their urban-type settlements and cities and their first-order neighbors have the best transport accessibility. It is important to note that this indicator depends not only on the actual situation from the city of Kharkiv to the relevant settlement. Another important factor is the availability of asphalt roads with satisfactory road quality. Based on the above, we can easily establish the core and outer zones of the agglomeration. Identification of areas belonging to the zone of influence of the agglomeration uses data that characterize industrial production, social infrastructure, tourism and recreation and logistics and transport, utilities, environmental status, etc [19]. According to a similar analysis, such a zone is located 70 km away from Kharkiv (Fig. 4).

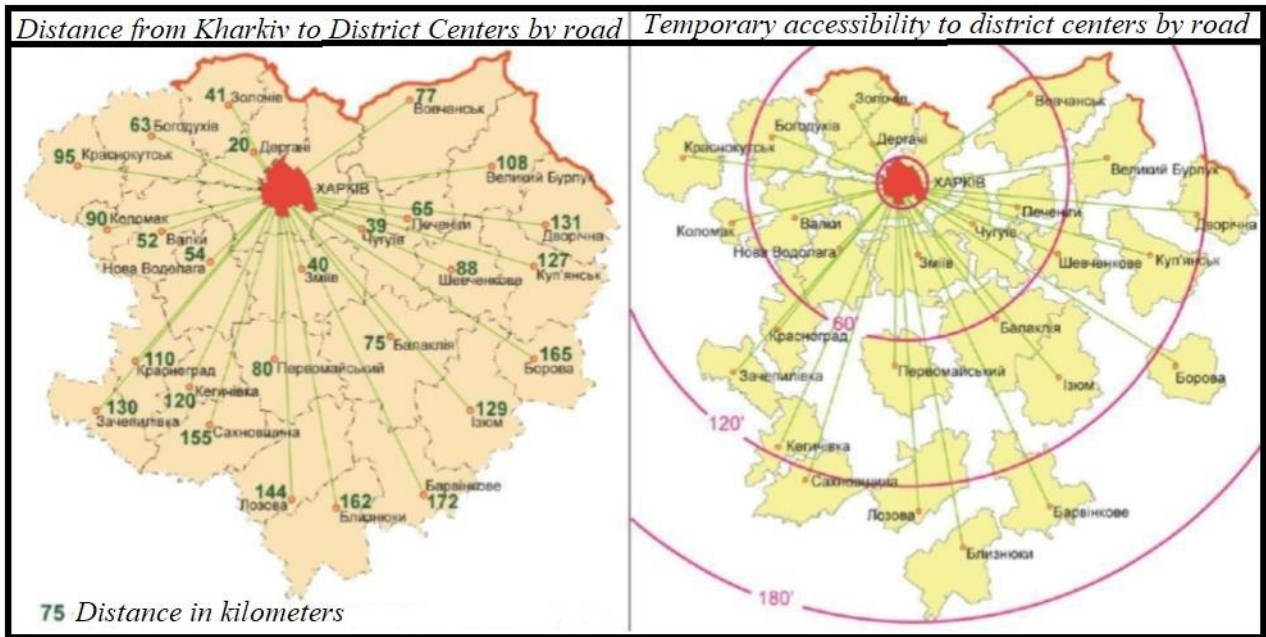


Fig. 3. Transport accessibility of district centers: average time trips from Kharkiv by car (in minutes) [19]

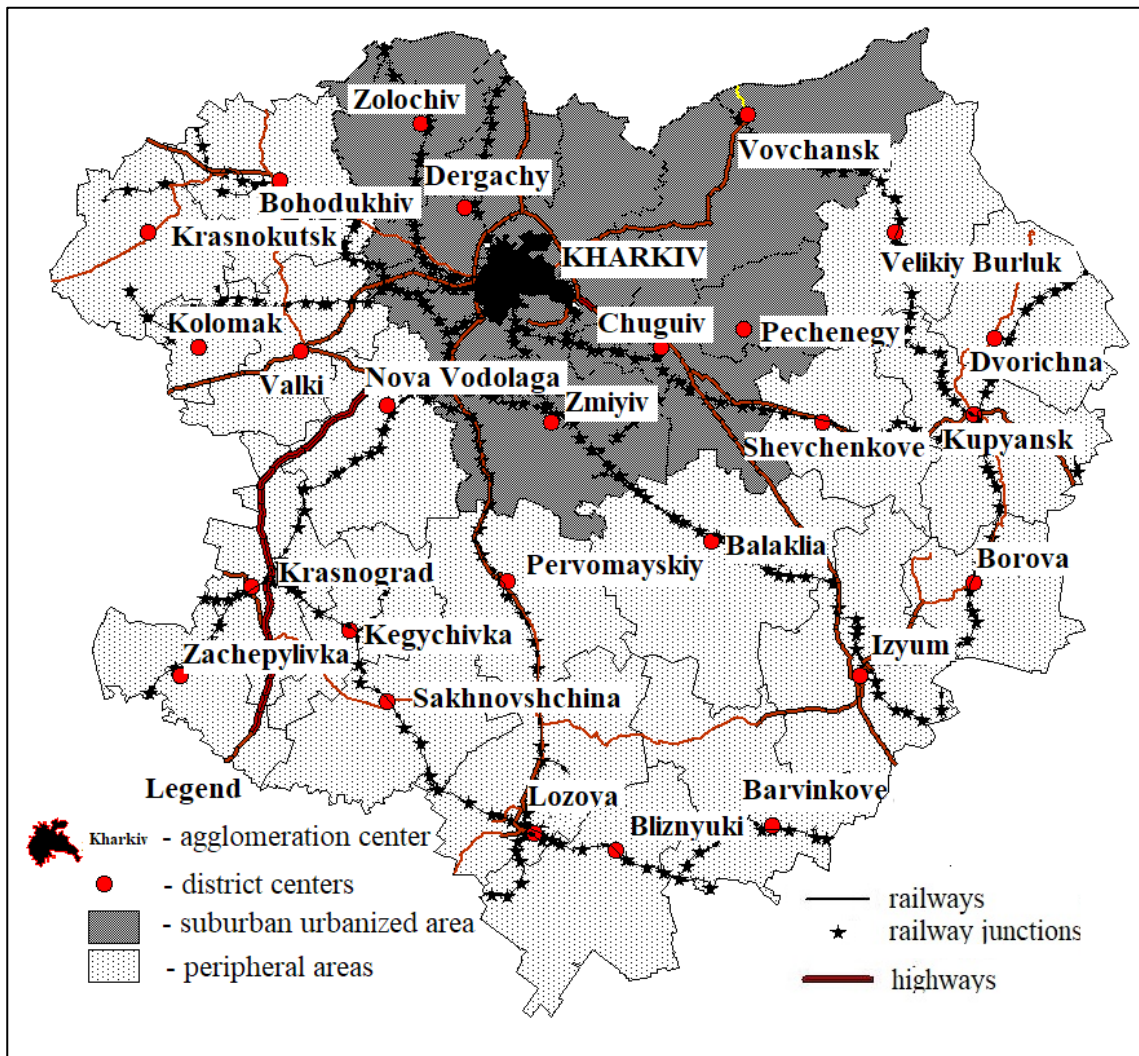


Fig. 4. Kharkiv agglomeration in 2019 (created by authors to [11])

Within its borders are the following cities of regional and district importance: Vovchansk, Zmiiv, Zolochiv, Lyubotyn Pechenyhy, Chuhuiv, etc.

Summing up, we note that the Kharkiv agglomeration has the following structure:

- the core of the agglomeration (Kharkiv);
- central zone of agglomeration (Kharkiv and Derhachiv districts);
- outer zone (Bohodukhiv, Valkiv, Vovchansk, Zmiiv, Zolochiv, Novovodolazk, Pecheneg and Chuhuiv districts).

Based on the results obtained, it should be noted that the Kharkiv agglomeration has a fairly compact

shape, and in fact includes almost half of the regions. The fact that the central zone of the agglomeration also includes the Chuhuiv district is associated with extremely intensive connections between the city of Kharkiv and the city of Chuhuiv, which are manifested not only in intensive transport and trade in goods and services, but in pendulum migrations of large populations Chuhuiv to Kharkiv.

We will use the principle of superposition and form the resulting map on the basis of the peculiarities of the distribution of indicators of population size and density, development of the transport system, transport accessibility (Fig. 5).

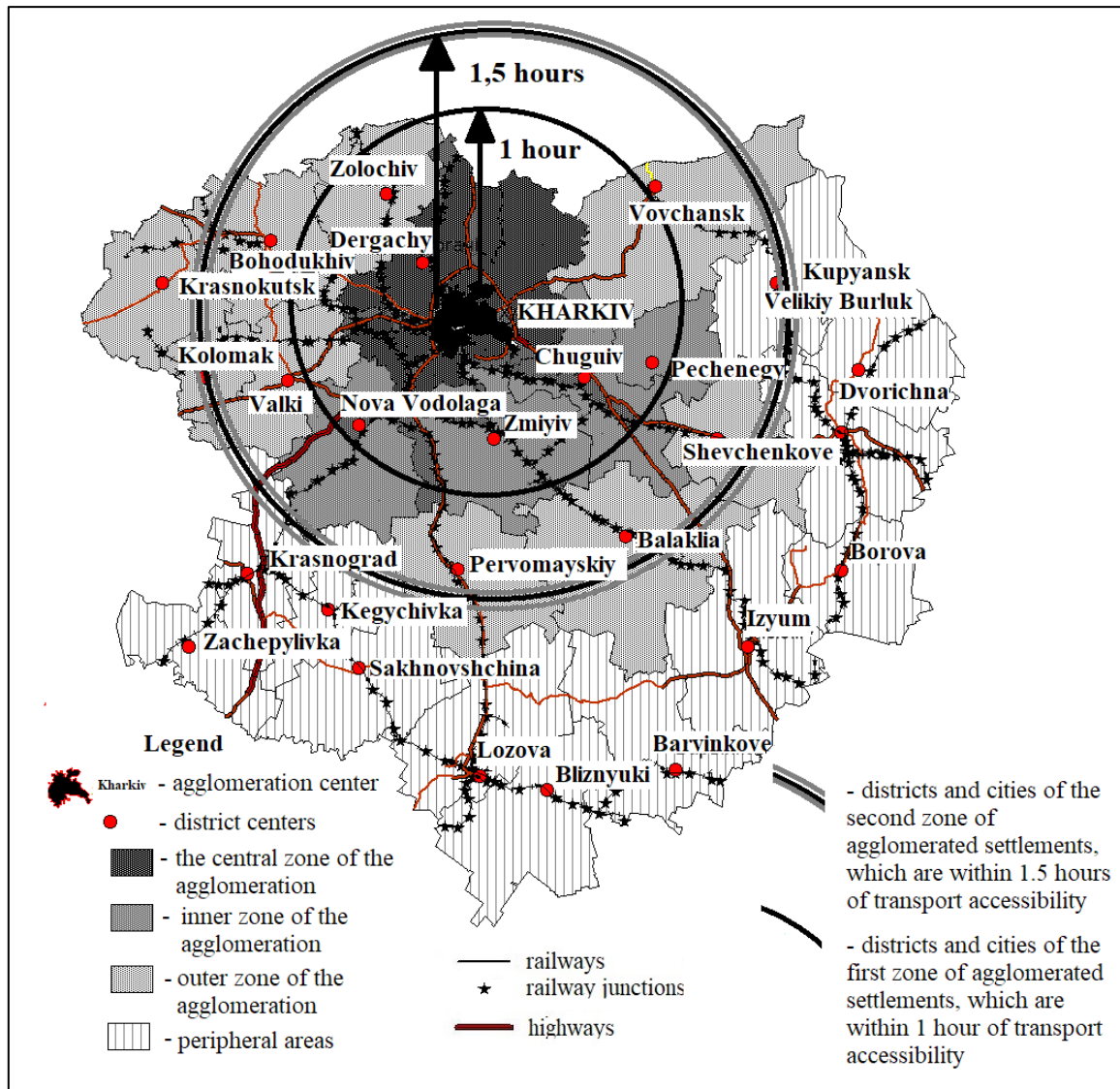


Fig. 5. Delimitation of the borders of the Kharkiv agglomeration in 2019 (created by the author to [11])

The calculations of the coefficient of development of the urban agglomeration, the coefficient and the index of agglomeration (according to formulas 1, 2, 3), which quantitatively characterize the state of development of the agglomeration, indicate that the Kharkiv agglomeration has a powerful organizational center – Kharkiv, whose polarizing effect manifested in two areas as close as possible to it. The center of the agglomeration

is also connected to the remote centers of the peripheral areas by radial-radial connections by transport and other types of connections.

The development of agglomeration on the territory of the region is an important stage on the way of complex development of the territory of Kharkiv region. After all, within the agglomeration there is a large number of economic processes, which is favorably

reflected in the living standards of the population. In the current state of development of the Kharkiv agglomeration, the following positive achievements can be identified:

- a powerful labor market has been formed, which focuses on the significant labor potential of the territory. The city of Kharkiv has the most favorable employment situation in the region, there is even a cumulative effect in creating new jobs;
- in the city of Kharkiv there is an extremely wide range of various social infrastructure institutions that provide services to both citizens and residents of the region;
- the city of Kharkiv as a powerful regional center specializes in providing trade, social security, etc., as well as for residents of neighboring regions, receives internally displaced persons from Donbass, Crimea;
- the speed of innovation is high in the region due to well-established communication and transport.

The Kharkiv agglomeration is developing quite effectively due to the process of diffusion of innovation. However, a negative phenomenon is the significant differentiation of the level and quality of life of the population of the center of the agglomeration and peripheral areas. The city of Kharkiv should accelerate the development of the surrounding areas. This is partly true, but some of them are gradually losing their potential in favor of the central city. Also, the problem of the evolution of the Kharkiv agglomeration is the rather slow formation of the agglomeration zone around the so-called "second level cities" – cities of regional and district subordination of the region. This raises the question of managerial influence and the need to implement regional policy focused not on the unit of administrative-territorial organization of the region and on the agglomeration as a single entity.

The main priority directions of transformational development of the Kharkiv agglomeration are presented in Table 2.

Table 2

Priority directions of development of Kharkiv agglomeration

(created by the authors according to [1; 2; 13;15])

№	Aspect of development	Main tendencies
1.	Transport and communication	The favorable transport and geographical position of the agglomeration provides opportunities to reduce travel time from the periphery to the core city of the agglomeration, ie the development of transport accessibility, which corresponds to the main features of urban agglomerations.
2.	Economy and production	Ensuring employment of the population living in the urban agglomeration. Availability of resources in the relevant area. Intensification of industrial development, public utilities in the periphery, restoration of lost industrial potential of cities.
3.	Culture and science	Preservation and strengthening of the existing scientific and educational infrastructure represented by both higher education institutions and research centers not only in Kharkiv but also in peripheral centers. Creation of technology parks.
4.	Ecological situation	The high concentration of productive forces on the territory of the agglomeration causes a significant release of harmful substances into the atmosphere, as well as an increase in the cost of neutralization of industrial waste.
5.	Administrative and territorial reform	The Kharkiv agglomeration should be used as a basis for the formation and cooperation of united territorial communities in the region.

The main task of regional policy is to increase the level and quality of life of the population, reducing territorial disparities in development. Therefore, it is important to organize constant monitoring of the manifestations of uneven economic development in the agglomeration zone, overpopulation, a significant increase in the number of private vehicles, which may directly or indirectly affect the quality of life. Another important task is the development of transport infrastructure, communication between cities and district centers of the Kharkiv region..

Conclusions. The analysis of approaches to delimitation of urban agglomerations showed that the main criteria for establishing agglomeration boundaries are indicators of population density and population size, features of demographic processes, transport

accessibility of the agglomeration center and the criterion of suburban areas. The combination of quantitative and qualitative methods for determining the boundaries of the agglomeration is the most effective, allows to obtain reasonable results.

Approbation of the proposed algorithm on the materials of Kharkiv region allowed to draw the following conclusions. The Kharkiv agglomeration is monocentric and fairly well formed. The development coefficient of the Kharkiv urban agglomeration is 30.7, the agglomeration coefficient is 0.13, the agglomeration index is 0.25, which confirms the high level of development of this agglomeration and the significant polarizing effect of the city of Kharkiv. The applied indicators of concentration and population density, transport accessibility, allowed to establish that the

Kharkiv agglomeration has a powerful organizational center of development – the city of Kharkiv, the polarizing effect of which is more pronounced in two districts – Kharkiv and Dergachiv, which form the central zone of the agglomeration. The outer zone of the Kharkiv agglomeration is formed in the territories of Bohodukhiv, Valkiv, Vovchansk, Zmiiv, Zolochiv, Novovodolazk, Pechenizh and Chuhuiv districts, which have radial-radial connections with the center of the agglomeration. Based on the study, based on the principle of superposition, the author's vision of delimitation of the boundaries of the Kharkiv agglomeration in 2019 is presented, the zone of influence of organizational functions of the center extends to a radius of 70 km. However, there are some issues related to the sharp contrast in the development of the center and the periphery of the agglomeration. The

city of Kharkiv assumes most of the functions: administrative, economic, social, infrastructural and recreational, which to some extent hinders the development of small towns that are part of the agglomeration. At present, the main issue in the development of both Kharkiv and other agglomerations of Ukraine is the legal uncertainty and the lack of a special normatively documented status for such territories. Given that the Kharkiv agglomeration is monocentric, and within it, as well as in the region there is a sharp uneven development of the center and periphery, effective management and addressing the hypertrophied development of the city, spatial planning and infrastructure development will alleviate this situation and facilitate the transition of the region. to the polycentric model of spatial organization.

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