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Methods of study population settlement in socio-economic geography

Abstract: The article deals with methods of study population settlement in socio-economic geography. It is specially noted features of type of population settlement. It is spoken in detail different methods of regional research. Much attention is given to centrographical method. The article gives a detailed analysis of spatial interaction between social and geographical objects. Finally, the role of the proposed methods is shown.

Keywords: human geographical research, type of population settlement, spatial characteristics, "rank-size" index, urban settlement, study of settlement system, centrographical method, the index of population concentration, Lorenz curve, the coefficient of priority, regional economy.

Through its complexity and interdisciplinary human geography has certain advantages in the study of demographic processes and it is an actual problem in the world in XXI century. This particularly concerns the spatial distribution of the population that is an actual direction of human geographical research as causes some features of accommodation of establishments and institutions of social infrastructure, makes demands from transport public service, of the affects the development of industries that provide its nutritional needs and industrial goods, after all, determins the conditions of domestic demand etc. [12, 13]. It largely depends from the population formation between settlements communications, organization of production capacity and flow structure of production in which take part one or another

area, the development of local production. [11]. At the beginning of XXI century the demographic processes are becoming extremely complex, the new conditions and factors are formed, large cities rapidly are growing their functions are changing, causing new problems of population, migration flows, etc. This publication makes an attempt to summarize scientific developments in the field of social geography in the postsoviet territory, including methodological developments of the authors in the study of population settlement.

Considering the world and European trends, it is important to define the type of settlement - the monocentric or polycentric, because it determines the spatial pattern of regional development. In general, monocentric settlement system is dominated in Ukraine, but one of the strategic priorities of the state after the signing of the Association Agreement with the EU is a transition to a polycentric model of spatial development, which means as a way of social and economic development of a territory, in which the population and economic activity are concentrated in a few (two or more) similar in size and geographically separated and functionally interrelated centers [1]. Such centers in the regions are becoming cities.

The researchers usually determine wo major aspects of polycentricity of settlement population: morphological and functional (in some sources - relational). According, there is a significant number of tools and indicators to measure the level of polycentricity settlement system [1]. The most common indicator of morphological polycentricity is the distribution of cities by size, which can be determined by the following factors: distribution of "rank-size" index of priority, the proportion of the population of the largest city to the total population of the area (or cities of a certain size), the average difference between the city and the next, smaller-sized city, the standard deviation of the population in the cities and some others. Also the measures of the morphological polycentricity the distribution of cities by GDP (gross national product) (determined by indicators of distribution "rank-size" and index priority) and the nature of the spatial distribution of cities (determined by the Gini coefficient according to the size of service areas). Functional polycentricity is expediently measured in following directions: the distribution of flows between cities (it is measured by the ratio of ordinary polycentricity and entropy index), the potential for interaction between settlements (it is calculated with the help of the index of multimodal accessibility of settlements) [1].

The rules of "rank-size". Construction and analysis of the rank of the largest series of urban settlements offered by J. Zipf and supplemented by Y. Medvedkov, are called "rank-size law" and "rule-Zipf Medvedkov". This method is widely applied in geography and settlement geourbanistics to study local populations cities. According to the hypothesis, as for some of the cities that make up a single settlement system (eg, a specific region of the country), there is a specific relationship between the population of the city and its serial number (rank) the degree of decline of population in cities in the form of parison (formula 1). Accordingly, the population size of a city is a product of the coefficient priority, the first population populous city and the contrast ratio of a settlement system. The latter is a measure that reflects the degree of excessiveness of the main city: its serial number in the elevated degree of contrast, which is typical for this settlement system.

As a rule, the existence of laws by Zipf is influence by several factors that significantly distort it, but this pattern is real. Its objective existence is confirmed by numerous works of Y. Medvedkov, who transformed Zipf equation in formula 2:

$$H_j = H_1 * j^{(-a)} \quad (1) \qquad H_j = K * H_1 * j^{(-a)} \quad (2)$$

where

H_j – humanity of j-th city;

H_1 – humanity the first populous city system;

$j^{(-a)}$ – contrast ratio, typical of a system of cities

where

Hj - humanity of j-th city;

H_1 – humanity the first populous city system;

j – city number reduce the degree of population;

$j^{(-a)}$ – contrast coefficient measures the size of a city;

K – "coefficient of priority main town, which is equal to C/H_1,

where C – humanity's main city (most important market center of the country or region), which theoretically should have been complied with population trends in the distribution of cities according to Zipf hypothesis [8].

As the linear scale on the vertical axis for the study of cities does not reflect the numerical differences, it is replaced by a log. This method just makes it possible to present the relationship between the population of the city and its rank in a linear form. By means of potentiation of the equation has a stepwise function $H_j = C*j^{(-k)}$, which is close to Zipf equation when $C = H_j$, $K = a = 1$.

The researching of the urban settlement of all regions of Ukraine with the help of the rule of "rank-size" according to the division of the complex of cities in the region compared with the "ideal" Zipf curve, the regional settlement system of Ukraine can be divided into three main groups: 1) close to the ideal distribution of Zipf; 2) twocentrycal (the curve is above ideal); 3) monocentric (the curve is below the ideal): 3.1) by approaching to the "ideal" central city dominates the other 3-5 times; 3.2) monocentric: the central city dominates the other 5-9 times; 3.3) strongly monocentric: the central city dominates the other more than 10 times [9].

The research of spatial interaction between social and geographical objects. The interaction of social and geographic objects depends on the radius of influence. Exactly this thing, as a function of spatial interaction placing social and geographical features, have been identified by us a part of their spatial interaction. The second component - attributive - determines the intensity of interaction and it is a function of the numerical value of the parameter (power) facilities Z. The main provisions are:

1. Determining the radius of influence of socio-geographic area, it is logically to assume that it must be proportional to the capacity of the facility Z. It follows that the least powerful object must have the least impact radius R_0 (which can be called the base) while the radius of influence of all other analyzed objects can be determined as a function of the base. We propose to differentiate the social and geographical features according to size of randious of influence by the following dependence (formula 3):

$$R_i = R_0 + k * \ln(Z_i / Z_{\min}) \quad (3)$$

where R_i – radius of influence the *i–th* socio-geographic area;

R_0 – base radius of influence;

Z_i і Z_{min} – the parameters and the *i–th* and basic facilities respectively;

k – scale factor.

Formula 3 shows that changing the radius of influence of socio-geographic area (and, consequently, the degree of generalization of surface interaction) can systematically done by through R_0 or by the ratio of the radii controlled scale factor k.

2. The intensity of the impact of socio-geographic area within its zone of influence decreases from the center to the periphery and often defined as the inverse proportion to the distance in a certain degree. We propose to use nonlinear invariant form of such relationship (formula 4):

$$\text{at } \boldsymbol{L \geq R\ \Delta = 0,}\ \text{at } \boldsymbol{L < R}\ \Delta = (1 - L/R)^n \quad (4)$$

where Δ – function influence the socio-geographic area;

L – current distance to the center of the zone of influence of socio-geographic area;

R – radius of influence of socio-geographic area;

n – exponent, defined arbitrarily.

3. Taking into consideration the dependence (formula 4) the parameter of influence socio-geographic area in the impact zone is defined by the formula 5:

$$\boldsymbol{p = Z^* \Delta} \quad (5)$$

where Z – quantitative parameter (power) socio-geographic area (center area of influence) [7].

An example of this method in the study of settlement system can be the result of the definition of organizational nuclei of settlement population in Kharkiv region and the areas of their influence on the model features of integrated field effect, which reflects the of spatial features of the interaction of all settlements within the region [7].

Centrographical method. Spatial distribution of the population has a two-dimensional character: the location of each unit i of the studied population on the surface (or in a separate area) is determined by its coordinates xi and yi. Consequently, according to the spatial distribution of the population a central point can be determine a central point to assess the individual dispersion units around and the asymmetry of distribution [3].

The central point of the spatial distribution is a composite index of spatial distribution. The determination of regional centers and their mapping is known in geography as scientific direction centrography, which is a part of geostatistics. Among the most common applications centrography method is to study the resettlement of the population (the definition of population center), identifying the main features of spatial and statistical distribution of the population in the territory. As the main indicators of the spatial distribution of the population can be used arithmetic, median and modal centers, which are determined in accordance with Cartesian coordinate system [3].

The arithmetic mean center is a measure of the central point of the spatial distribution of the population. It is measured using two coordinates x and y, which form straight lines that intersect at a point of arithmetic centre of the region. To determine the arithmetic center we need scale the number of distances (the length of

the region) multiplied the population of its administrative units and divided into the population of the region (separately - in x and y) (formula 6-7).

$$x = P_{p-r} \times L / P \quad (6) \qquad y = P_{p-r} \times L / P \quad (7)$$

where P_{p-r} – the population of the administrative-territorial unit area;

L – the distance between the vertical (horizontal) straight;

P – population of the region [3].

The median center of the spatial distribution is similar to the median in linear statistics. It can be seen as the point position that divides the number of the population into two equal parts by latitude and longitude. In other words, the median center of the spatial distribution is a point on the surface, the sum of the distances to which from all other units of the population is minimal. Modal Center can be defined as the highest point on the surface area of distribution. This is one of the most important indicators of the spatial distribution, which determines the place of greatest population concentration and is independent on the other accommodation units [3]. The center of gravity of the geographical phenomenon is called a point with average coordinates from the geographical coordinates of individual centers (as small as possible) territorial subdivisions of the region, weighted by quantity (mass) of any signs of these areas. Treating the "center of gravity", it should be noted two characteristics: a statistic, the number of events and a location (geography, quantified way in coordinates). Thus, the center area is a point to which area has symmetrical properties (formulas 8-9).

$$x_0 = \frac{\Sigma(p_i - p_0)x_i + p_0 x_1}{\Sigma p} \quad (8) \qquad y_0 = \frac{\Sigma(p_i - p_0)y_i + p_0 y_1}{\Sigma p} \quad (9)$$

where x_0, y_0 – coordinates of the center;

p – the population of the region;

p_i – the population of the region unit;

p_0 – population centers administrative political unit area;

x_i, y_i – coordinate administrative unit in the region;

x_1, y_1 – coordinate administrative centers of administrative-territorial unit area [3].

Applying the centrographycal method in studing the system of settlement of the Kharkiv region, the median, modal centers and the center of gravity of the region, were determined all of them are on or near the regional center - the city of Kharkiv [13].

Exploring the operational centers, one can use both traditional and non-traditional methods. The nontraditional methods of centrography include a topological ones centrography for which values are not fixed on the field of space, but the ratio of mutual accommodation areas, lines and nodes (points) [14]. One of the most effective methods of topological centrography is to determine the central point in the system of points, provided in the form of flat graph. If vertices are the centers of settlement (for example, regional administrative centers of Ukraine or regional centers of a certain region), and the edges are the real or abstract relation of the neighborhood, the central point is determined by using the number Koenig (top eccentricity) [14].

Eccentricity of the top is the minimum distance (number of edges of the graph) between this peak and the most remote from it peak in this graph.

The index of population concentration. The uniformity and not uniformity of population settlement can be quantitavely determined by using the coefficient (index) of population concentration, which shows the distribution of population by administrative units in relation to the total population of uniformity territory. The index of population concentration of a given region is calculated as the half of the amount of shares differences of population and area of all its administrative units (formulas 10-12) [8].

$$IPC = \frac{\sum |P_q - S_q|}{2} \quad (10)$$

The proportion of the area of administrative-territorial units:

$$S_p = \frac{S_{ATU}}{S_{per.}} \times 100\% \quad (11)$$

where: S_p – share of area of the administrative unit of the region;

S_{ATU} – area administrative unit in the region;

$S_{per.}$ – area of the region.

The proportion of population in administrative unit:

$$P_p = \frac{P_{ATU}}{P_{per.}} \times 100\% \quad (12)$$

where: P_p – the share of the population of the region unit;

P_{ATU} – population of the region unit;

$P_{per.}$ – population of the region.

The index of population concentration can range from 0 to 100% - live on 1% of territory, from completely uniform, when 1% of the population to a completely uneven. When the coefficient is to 20% - the distribution of the population is uniform 20 to 40% the distribution of the population is uneven, 40% or more distribution of the population dramatically uneven [8].

The results of the calculation of the index of concentration of population in the regions of Ukraine show the uneven distribution of the population on the territory of Ukraine [4, 6, 13].

Lorenz curve. Lorenz curve is a graphic method of concentration phenomenon. For its on both axes making an interest scale bar is insertes (0 to 100%). For points of the curve abscissa are the units of summation and ordinates – are the main features. The uniform distribution characteristics presented in this case as a diagonal, which is called "line of equal distribution" and uneven - "Lorentz line", which deviations from the diagonal represents the degree of unevenness. In assessing the population distribution the ratio of the area and population within the administrative units of the region is analyzed [5].

The results of the Lorenz curve as for the distribution of population in the Kharkiv region shows that more than half the region's population (53.2%) lives on 1% of the (Kharkiv territory), 21% of the population lives on 20% of the territory. Accordingly, 80% of the region is home for 26% of the population [10].

The coefficient of priority. "The coefficient of priority" is expressed as a specific gravity of the population of the largest city of the region to the total population of the region. Clearly, the most significant features of monocentric settlement system have the regions have the highest rate of the priority and the most polycentric regions with the lowest ratio of priority. Thus all regions of Ukraine according to the rate of priority can be divided into four groups: regions with the lowest ratio of priority (less than 20.0%), with the coefficient below the average coefficient of priority (20,0-27,9%), above average (28,0- 35.9%) and the highest rate of priority (36.0% and above) [4].

The use of these techniques in socio-economic studies is necessary for a comprehensive analysis of settlement and determining the prospects of their further development. Most of them are focused on determining the impact of cities, urban settlements on the formation of settlement systems in the region and identifying the spatial characteristics of the area. Each of the proposed techniques can detect certain characteristics of the settlement of the region, the most significant of which is

the type of population settlement - polycentric or monocentric, which in its turn determines the characteristics of further development of settlement, the demographic potential and the regional economy.

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