Assessment and mapping of demographic potential of urbanized territories of the Baikal-Mongol region

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Abstract. This article provides an assessment of the demographic potential of the Baikal-Mongolian region, which unites the adjacent territories of the two countries. The cores of the research site are the urbanized territories of Irkutsk, Ulan-Ude and Ulan-Bator, and communications are railways and highways connecting the main centres. The demographic potential is characterized by the level and possibilities for the development of demographic processes and population structures, and mainly numerous quantitative characteristics of the population of the territory are used. The authors limited themselves to using quantitative characteristics of the demographic potential according to statistical data for 2019–2020 within the territories of the municipal districts and urban districts of the Irkutsk region, the Republic of Buryatia and aimags of Mongolia. Data on density and proportion of urban population reflect the size of the main urban areas. Data on demographic processes reflect the characteristics of the natural and migration movement of the population. Demographic structures are represented by the age structure and the demographic load of the working-age population, which is minimal throughout Mongolia and in the suburbs of Russian regional centres. Generalizing characteristics of demographic potential calculated from the average sum of individual indicators.

1. Introduction
Currently, the problem of scientific substantiation of the complex use and interaction of socio-economic, natural-resource, socio-demographic potential of spatial development is urgent. In the case of a transboundary region, the problem of the potential for regional development is complicated by interstate interactions, different institutional frameworks, and sociocultural differences.

In the previous study, it was proposed “to interpret the socio-demographic potential as a combination of qualitative and reproductive characteristics of the population. The level of human development, which has a high degree of stability, is estimated for the quality of the population, and the level of the net reproduction rate reflects the long-term (one generation of people) features of the dynamics of the population” [1, p. 38] Socio-demographic potential is an assessment of not only demographic processes and structures, but socio-economic, cultural, political, and environmental characteristics of the population (employment, income, housing conditions, education, health, recreation, crime, religion, ethnus, etc.) of different quality. The multidimensionality of the different-quality characteristics of the population complicates the formalization and comparability of indicators. Therefore, it makes sense to concentrate on considering the system of related demographic indicators of spatial development. Combining the geographical and demographic aspects of spatial social development allows the cartographic method to display the relationship between demographic indicators and other parameters of the territory [2].
At the beginning of the XXI century, especially in recent years, materials were repeatedly published concerning complex geographical studies of the natural, resource, economic, demographic, and ecological state of Siberia [3], urbanized territories [4], near-border and transboundary territories [5], the influence zone of the Trans-Siberian Railway [6], the Lake Baikal basin [7], The Baikal region [8, 9], The Baikal-Mongolian economic corridor [10-14]. The results of numerous studies concerning the population of the Baikal-Mongolian transboundary region made it possible to formulate scientific problems, select a methodology and assess the demographic potential of urbanized and adjacent territories. This work deepens the substantiation of the significance of the territorial differentiation of the demographic potential of the Baikal-Mongolian region, which unites the adjacent territories of the two countries. The cores of the research site are the urbanized territories of Irkutsk, Ulan-Ude and Ulaanbaatar and communications are railways and highways connecting the main centres.

2. Models and Methods

The informational basis of the work was formed by statistical materials of the Federal State Statistics Service of the Russian Federation (url: https://rosstat.gov.ru) and the National Statistical Service of Mongolia (url: https://www.1212.mn). The units of statistical observation are Russian urban districts and municipal districts, as well as the capital city and aimags of Mongolia. There is an asymmetry between the Russian and Mongolian administrative-territorial units used in work: the average aimag has an area of 30 thousand km² and a population of 105 thousand people, and the average district has 7 thousand km² and 49 thousand people, respectively. It is also necessary to take into account that the Mongolian regions are better provided with demographic statistics than the Russian municipalities. Therefore, the minimum data set is guided by the capabilities of the Russian statistical base.

In this article, the authors use a geographic and demographic approach, which makes it possible to interpret the most significant statistical indicators of the demographic situation in the context of administrative-territorial entities. The demographic potential is characterized by the level and possibilities for the development of demographic processes and population structures, and mainly numerous quantitative characteristics of the population of the territory are used.

The scientific problem solved by the authors of the article is the study of demographic processes and structures and a comparative assessment of the integral demographic potential in the cities of southeastern Siberia and Mongolia. The distribution of the population, the features of urbanized settlement, the current state and current changes in demographic processes and structures within the spatial framework of the Baikal-Mongolian region were investigated. Based on a statistical assessment of the integral demographic potential, mapping was carried out and a territorial grouping of the cities, districts, aimags under consideration was made.

3. Results and Discussion

The conducted research consists of two interrelated parts: informational-methodical and analytical (comparative-geographical, including cartographic).

Informationally, the data refer to the characteristics of settlement, demographic processes and demographic structures. Data on density and proportion of urban population reflect the size of the main urban areas. Data on demographic processes reflect the characteristics of the natural and migration movement of the population. Demographic structures are represented by the age structure and the demographic load of the working-age population. Generalizing characteristics of demographic potential calculated from the average sum of individual indicators.

To assess the demographic potential, 10 commonly available statistical indicators were used that characterize certain aspects of the population (Table 1, Table 2).

Consideration of the demographic development of cities, districts and aimags by particular indicators allows us to formulate a number of statements: the spread of indicators is very significant; there are both positive and negative values; there are indicators (for example, the aging index) that have a “reverse” dynamic, when their growth means a worsening of the situation.
Table 1. Indicators used to assess demographic potential.

| Characteristics of the population | Indicators, units of measure | Indicator values |
|----------------------------------|-----------------------------|------------------|
| Age structure of the population  | Demographic load ratio for the working-age population, % | 704.00 - 1,089.00 |
| Population aging                | Aging index, \( I_{aging} = \frac{(65 + \text{years})}{(0-15 \text{years})} \) | 0.28 - 1.29     |
| Infant mortality                | Infant mortality rate, ‰ | 2.1 - 15.0       |
| Fertility                       | Crude birth rate, %       | 9.5 - 27.0       |
| Mortality                       | Crude death rate, %       | 4.5 - 18.6       |
| Natural population growth       | Crude natural increase rate, ‰ | -5.3 - 21.7     |
| Population growth               | Population growth rate, % | -16.6 - 44.3     |
| Migration                       | Net migration rate, %     | -19.5 - 36.9     |
| Marriages                       | Crude marriage rate, %    | 5.1 - 11.4       |
| Divorces                        | Crude divorce rate, %     | 1.0 - 5.7        |

Table 2. Indicators of the demographic potential of urbanized areas.

| Indicators, units of measure | Indicator values in cities |
|------------------------------|---------------------------|
|                              | Irkutsk | Ulan-Ude | Ulaanbaatar |
| Surface area, km²            | 277     | 348      | 4,704       |
| Population, thousand people  | 623.6   | 439.1    | 1,539.8     |
| Population density, people per km² | 2,251.0 | 1,261.8 | 327.3 |
| Demographic load ratio for the working-age population, % | 714 | 704 | 760 |
| Aging index, \( I_{aging} = \frac{(65 + \text{years})}{(0-15 \text{years})} \) | 1.02 | 0.80 | 0.28 |
| Infant mortality rate, %     | 5.7     | 5.2      | 15.0        |
| Crude birth rate, %          | 12.0    | 12.0     | 27.0        |
| Crude death rate, %          | 10.8    | 9.3      | 5.3         |
| Crude natural increase rate, % | 1.2     | 2.7      | 21.7        |
| Population growth rate, %    | 0.1     | 8.3      | 25.5        |
| Migration growth rate, %     | -1.1    | 5.6      | 3.8         |
| Crude marriage rate, %       | 7.8     | 6.1      | 11.4        |
| Crude divorce rate, %        | 5.4     | 3.9      | 2.9         |
| Integral index of demographic potential | 0.40 | 0.47 | 0.75 |

Due to the different content and different dimensions of the characteristics of the population, it is required to bring them to a single basis, that is, it is necessary to normalize them into a single scale. The well-known method “minimax” is used, when the range of variation of each indicator is taken as a unit, and on the entire distribution of values the indices change from 0 (minimum value) to 1 (maximum value).
The indicator is normalized into an individual index by dividing the difference between the given and the minimum value by the difference between the maximum and minimum values. Generalizing characteristics of the demographic potential calculated from the average sum of separate individual indices. Theoretically, the integral indices of demographic potential can vary from 0 to 1, but in reality, for example, in our particular case, they take values from 0.20 to 0.75.

Figure 1. Demographic potential of cities, districts and aimags as of 01.01.2020. Numerical values of the index: high (0.8–1.0), increased (0.6–0.8), average (0.4–0.6), reduced (0.2-0.4), low (0.0-0.2).

The main urbanized territories, with the centres of Irkutsk, Ulan-Ude and Ulaanbaatar, differ in the parameters of many particular demographic processes and structures (Table 2). Most of the demographic parameters of Ulan-Ude occupy an intermediate position between Irkutsk and Ulaanbaatar, but closer to Irkutsk.
The ranking of cities, districts and aimags according to the value of the demographic potential index shows that the distribution of administrative-territorial entities by the levels of demographic potential is uneven: high (index = 0.8-1.0) – no; increased (0.6-0.8) – 4; average (0.4-0.6) – 6; reduced (0.2-0.4) – 10; low (0.0-0.2) – 2. The distribution is asymmetric relative to the middle – half of all administrative-territorial entities belong to groups with a low and low level of the demographic potential index (Figure 1).

Increased values are only available in Mongolia, average values are typical for Russian regional centres and their immediate surroundings, and Irkutsk (0.55) and Ivolginsky (0.58) districts significantly exceed the indicators of the cities of Irkutsk (0.40) and Ulan-Ude (0.47), respectively. The differences in the demographic and spatial development of Ulaanbaatar and Irkutsk are known to researchers of the respective agglomerations “The dynamic growth of the Ulaanbaatar UA [urban agglomeration] and the suburbanization of the Irkutsk UA [urban agglomeration] lead to a functional reorganization of space and the urban environment as a whole” [15, p. 190] The entire Russian periphery of the Irkutsk region and the Republic of Buryatia has decreased values of the demographic potential index. The maximum demographic potential index (0.75) in the growing cities of Mongolia – Ulaanbaatar and Erdenet (Orkhon aimag). The minimum demographic potential index (0.20) is characteristic of the stagnating cities of the Irkutsk region (Usolye-Sibirskoye and Svirsk), which lost a significant part of the population in the post-Soviet period.

The proposed methodology for the relative assessment of the integral demographic potential can be developed in the direction of improving the information (new data, territorial divisions) and the calculation part (statistical procedures, accuracy). In general, the relative values of the demographic potential testify to the current (2020) state of the population of the estimated regions and can serve as indicators of demographic development prospects.

4. Conclusion
The study made it possible to clarify the existing and obtain new geo-demographic knowledge about the particular processes of the population of the territory, the dynamics of the population and the results of demographic and migration processes, the integral demographic potential of the development of the urbanized territories of the Baikal-Mongolian region.

The proposed method for assessing the integral demographic potential can be developed in the direction of improving the calculated part, expanding the information base of demographic indicators, supplementing the demographic block with neighbouring economic, socio-cultural, settlement indicators, taking into account the experience of other studies and used for other types of territories.

The ranking of cities, districts and aimags according to the value of the demographic potential shows that the increased values are only found in Mongolia, the average values are typical for the Russian regional centres and their immediate surroundings, and the entire Russian periphery has lower values. The maximum demographic potential index (0.75) in the growing cities of Mongolia - Ulaanbaatar and Erdenet (Orkhon aimag). The minimum demographic potential index (0.20) is characteristic of the stagnating cities Usolye-Sibirskoye and Svirsk.

The influence of urbanized areas in places of maximum population concentration is substantiated: in Mongolia around the capital city of Ulaanbaatar, and in southeastern Siberia around the regional centres of Irkutsk and Ulan-Ude. The determining factors of socio-economic development are the effects of the economic and geographical location and the accumulated socio-economic potential of the urbanized territories in relation to the adjacent spaces of the Baikal-Mongolian region.

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