Demographic dynamics of cities in the Baikal-Mongolian transport corridor

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Abstract. The article studies the spatial and temporal dynamics of the population of urbanized areas in the neighboring territories of Siberia and Mongolia connected by transport communications. The units of observation taken for the research are urban districts and municipal districts in Russia, and the capital city and aimags in Mongolia. Official statistics give a picture of the administrative-territorial observation units for Irkutsk and Ulan-Ude, without taking into consideration the peculiarities of the people’s settlement and the suburban population, and for Ulaanbaatar, within the official borders, it includes unpopulated territories that are many times larger than the area of the city itself. To map densely populated areas, night satellite imagery and statistical data on the population were used. As a result of night satellite image processing, maps are created that reflect constant light radiation in populated and used territories. The main urbanized areas were formed around the capital city of Ulaanbaatar in Mongolia, and around the regional centers of Irkutsk and Ulan-Ude in Siberia. The demographic potential of the Baikal-Mongolian transport corridor is more than half of the population living in the corresponding regions. The main promising direction in the development of the settlement system will obviously be the building economic, demographic and social potential in few centers and areas of their influence during the depopulation of the periphery.

1. Introduction

The subject of this study is the spatial and temporal features and trends in the dynamics of the population of the urbanized areas of the Baikal-Mongolian transport corridor. The model testing ground is the territory of South Siberia and North Mongolia, along which the railway line connecting Russia and Mongolia from Irkutsk to Ulaanbaatar passes [1]. Demographic processes are considered in the adjacent territories of two countries, united by a transport corridor. The population of the territories of Siberia and Mongolia is very different which creates completely different conditions in terms of the contacts intensity among people in settlement systems. There is a certain similarity of demographic processes for urbanized territories of Buryatia and Mongolia [2]. Population growth in suburbs of capitals [3]. In Buryatia, migration is directed to Ulan-Ude and the European part of the country. In Mongolia migration is directed to Ulan-Bator city and to border zone (towards Russia) [4]. Migration has had negative results both in the border aimags of Mongolia and in the border areas of Siberia [5]. The asymmetry of development of border regions is not in favor of Russia [6].
A transport corridor, as a form of spatial organization of transport, is a territory, the centers of economic activity of which are connected by various communications, in the presence of a general direction of this activity results’ displacement both within the corridor and in transit through the transport corridor [7]. A «agreement on developing the China-Mongolia-Russia economic corridor provides the framework for implementing potential joint projects» [8, p 1]. A economic corridor can become a catalyst for deepening economic cooperation between neighboring countries [9]. The settlement system of the Baikal-Mongolian region has a strong linear feature. In its structure, one can distinguish the main latitudinal axis - the Trans-Siberian railway and the meridional direction - the southern branch of the Trans-Siberian (Ulan-Ude-Naushki) along the Mongolian railway, reinforced by parallel and transverse highways.

Pulling the population into the largest cities and suburban areas leads to the depopulation of the entire vast periphery and semi-periphery near the highway. Small in area urbanized territories of intensive development are distinguished in the form of a broken chain along the highway.

The purpose of this article is to study the population dynamics of the urbanized areas in the Baikal-Mongolian transport corridor from Irkutsk through Ulan-Ude to Ulaanbaatar, where the railway and highway connecting Russia and Mongolia pass.

2. Objects, data and methods
Official statistics give a picture of the administrative-territorial observation units for Irkutsk and Ulan-Ude, without taking into consideration the peculiarities of the people's settlement and the suburban population, and for Ulaanbaatar; within the official borders it includes unpopulated territories that are many times larger than the area of the city itself [10].

To map densely populated areas (urbanized areas), we used materials from night space imagery with the DMSP OLS (Operational Linescan System of Defense Meteorological Satellite Program) equipment of the American Space Agency NASA [11] and data from the Federal State Statistics Service (Rosstat) and the National Statistics office of Mongolia about the population density of settlements. Night imagery data provide opportunities for displaying and monitoring a variety of population activities, including the distribution and growth of population, the degree and rate of urbanization, and the identification of undeveloped areas. Night satellite imagery can be used as an additional source of information when analyzing a complex combination of population density and the level of economic development of a territory [12].

The main arrays of statistical information are taken from the Rosstat reference books “Demographic Yearbook of Russia” (2019), “Regions of Russia. Basic social and economic indicators of cities” (2018), “The size and migration of the population of the Russian Federation” (2020), “The population of the Russian Federation by municipalities” (2020).

The units of observation taken for the research are urban districts and municipal districts in Russia, and the capital city and aimags in Mongolia. The distance between the main cities by rail makes 456 km (Irkutsk - Ulan-Ude), and 657 km (Ulan-Ude – Ulaanbaatar). The population of the main cities in 2020 is 624 thousand people in Irkutsk, 439 thousand people in Ulan-Ude, 1445 thousand people in Ulaanbaatar.

The data obtained from night satellite imagery allow identifying spatially expressed social and economic phenomena, such as the population density of a territory. Because of image processing, maps are created that represent constant light radiation in populated and used territories. A discontinuous chain of populated areas is visible along the transport highway. Individual urbanized areas have a population density of several hundred or even several thousand people per square kilometer, which contrasts with the background in the form of sparsely populated regions.

3. Results and Discussion
The main urbanized areas were formed in the south of Eastern Siberia along the Trans-Siberian Railway in places with the highest concentration of population around the regional centers of Irkutsk and Ulan-Ude in Russia and around Ulaanbaatar in Mongolia. In particular, in the Irkutsk region, the
main urbanized territory is manifested in the form of a strip with a length of up to 200 km and the width of up to 40 km when crossing Irkutsk, but then it narrows strongly in the north-west direction. The main urbanized part, which includes Irkutsk, Angarsk, Usolye-Sibirskoye and Shelekhov, together with the surrounding villages and rural settlements, has an average population density exceeding 200 people/km² [12].

The study area is the mainline territory of southern Siberia and northern Mongolia from Irkutsk to Ulanbaatar with a population of 3,716.2 thousand people on an area of 186.8 thousand km². Within this territory, the main population is concentrated in the main cities. Irkutsk, Ulan-Ude and Ulaanbaatar account for more than 2/3 of the population of the Baikal-Mongolian transport corridor (table 1).

Table 1. The area of the territory and the population of the municipalities of Russia, the capital and aimags of Mongolia located along the railway from Irkutsk to Ulaanbaatar in 2020.

| Municipalities of Russia, the capital and aimags of Mongolia | Territory area, km² | Population, thousand people | Population density people /km² |
|------------------------------------------------------------|----------------------|-----------------------------|-------------------------------|
| Irkutsk city                                               | 277                  | 623.5                       | 2251.0                        |
| Angarsk city                                               | 1150                 | 236.9                       | 206.0                         |
| Irkutsk district                                           | 9200                 | 136.9                       | 14.9                          |
| Shelekhovsky district                                     | 2100                 | 68.4                        | 32.6                          |
| Slyudyansky district                                       | 5300                 | 39.1                        | 7.4                           |
| Ulan-Ude city                                             | 348                  | 439.1                       | 1261.8                        |
| Kabansky district                                          | 13537                | 55.5                        | 4.1                           |
| Pribaikalsky district                                      | 15472                | 26.3                        | 1.7                           |
| Zaigraevsky district                                       | 6602                 | 51.4                        | 7.8                           |
| Ivolginsky district                                        | 2067                 | 59.1                        | 28.6                          |
| Tarbagatay district                                        | 3304                 | 22.4                        | 6.8                           |
| Selenginsky district                                       | 8269                 | 41.3                        | 5.0                           |
| Dzhida district                                            | 8628                 | 23.4                        | 2.7                           |
| Kyakhtinsky district                                       | 4663                 | 36.5                        | 7.8                           |
| Capital Ulaanbaatar                                        | 4700                 | 1444.7                      | 307.4                         |
| Aimag Selenge                                              | 41200                | 109.3                       | 2.6                           |
| Aimag Darkhan-Uul                                          | 3280                 | 104.2                       | 31.8                          |
| Aimag Orkhon                                               | 840                  | 103.2                       | 122.9                         |
| Aimag Tuva                                                 | 74000                | 95.0                        | 1.3                           |
| Highway areas, total                                       | 186790               | 3716.2                      | 19.9                          |
| Mongolia, Buryatia and Irkutsk region, total               | 2690280              | 6587.1                      | 2.4                           |

*according to data the Federal State Statistics Service (RF) and the National Statistics Office of Mongolia

To study the spatial features of population distribution, a map of the areas of population concentration was compiled. The map was compiled using night space imagery, which helps to display the results of various activities of the population. The map allows you to visualize the differentiation of territories into populated and uninhabited territories and to avoid the drawbacks of the cartogram of administrative territorial units as a whole (figure 1).

Population reproduction trends are generally civilizational in nature and display long-term qualitative changes in people's lives. However, sometimes they change drastically under the influence of some cyclical changes in the population. So, demographic processes at the beginning of the XXI century are characterized by a low birth rate, the reasons for which are the dominance of a modern model of a small family, reducing the absolute number of women in reproductive groups, postponement or refusal to have children due to socio-economic instability. After 2000, there have been trends in the growth of the total fertility rate, which is associated with an increase in the number
of 20–29-year-old women, who account for two-thirds of births. The potential of the age structure was short-term and began to decline after 2015, when the group of 20-year-olds was made up of a small generation born in the 1990s. The low fertility after 2020 is the third lowest in the post-war demographic wave after the lows of 1970 and 1995.

Figure 1. Areas of population concentration in the Baikal-Mongolian transport corridor.

The age structure of the population displays the long-term course of demographic and migration processes, constantly changing the number and ratio of different age groups of the population. Locations with a young structure of the population have a high birth rate and, as a consequence, an increased proportion of children, which is displayed in a high proportion of the population group under the working age. Territories with a significant influx of population are distinguished by a high proportion of able-bodied population groups, which can be seen from the example of suburban areas.
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of regional centers - Irkutsk district (near Irkutsk) and Ivolginsky district (near Ulan-Ude). As a rule, deprived areas have an increased proportion of older age groups, which distinguishes the Slyudyansky and Kabansky districts in the Baikal region, where environmental restrictions on economic activities are in force.

![Figure 2. Dynamics of the urban population in 1970-2020.](image)

Population migration is of great importance, but the migration pattern differs across regions and settlements. On both sides of the Russian-Mongolian border most of the territories are migration donors. The migration redistribution of the population in the Mongolian part of the transport corridor

![Figure 3. Population dynamics of the largest cities in 1980-2020.](image)
is unilateral in favor of Ulaanbaatar. In the Russian part of the transport corridor, migration is in favor of regional centers and their suburban areas.

Urbanization processes in Siberia and Mongolia developed asynchronously. Siberia was characterized by accelerated urbanization in the 1930-1950s, whereas in Mongolia this process was catching up. Therefore, if in the last 30 years the growth of the urban population in the Irkutsk region (as in the whole of Russia) has stopped and the number of urban dwellers has decreased, then in Mongolia the urban population has almost doubled (figure 2).

In general, Mongolia is experiencing rapid demographic growth, which is especially accelerated in the capital, Ulaanbaatar, where increase of population was 169% in the period 1990-2020 (figure 3). Russian cities have not grown demographically much due to the exhaustion of the demographic component of Russian urbanization. Therefore, the population growth gained, respectively, 7% in Irkutsk and 23% in Ulan-Ude in the period 1990-2020.

4. Conclusions
In general, the settlement system of the Baikal-Mongolian transport corridor is highly developed relative to other Siberian and Mongolian territories, there is a relatively high density of urban settlements. Here the main administrative, cultural and economic centers are located which concentrate the population, modern industries and innovative industries and where transit transport functions and management of Siberian regions are carried out.

The modern demographic dynamics is formed under the influence of various factors:
• features of a sparsely populated region, which has the property of supercontinentalism and remoteness from the economic centers of the world;
• the existing system of settlement, in which the employment opportunities of the population are changing, causing migratory movements of the population;
• geopolitical factors of interaction with neighboring regions and countries.

The demographic potential of the Baikal-Mongolian economic corridor is more than half of the population of the corresponding regions, while it reproduces and receives migrants from peripheral territories. The processes of "point" concentration are especially strong in Ulan-Ude and Ulanbaatar, which respectively accounts 45% of the population of Buryatia and Mongolia. The example of Irkutsk shows the importance of suburbanization processes, when the periphery is growing faster than the main city. The main promising direction in the development of the settlement system will obviously be the pulling together of the economic, demographic and social potential in a few centers and zones of their influence during the depopulation of the periphery.

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References
[1] Transsib Zone as the Eurasian Economic Corridor 2016 ed L M Korytny (Irkutsk: Publishing House V B Sochava Institute of Geography SB RAS) p 213
[2] Shartova N V, Enkh-Amgalan S and Malkhazova S M 2019 Public health of urbanized territories of the Republic of Buryatia and Mongolia Geography and Natural Resources 5 192-6 doi:10.21782/GIPR0206-1619-2019-5(192-196) (in Russian)
[3] Breslavsky A S 2019 Urbanization in the Republics of South Siberia: Dynamics of Key Parameters (1989-2019) Urbanistics 1 58-67 doi:10.7256/2310-8673.2019.1.29217 (in Russian)
[4] Gonchikov C D, Urbanova Ch B, Dymchikova B C and Erdenesuh S 2019 Spatial-time aspects of migration of the population in the frontier areas of the Mongolian platoon (on the example of Buryatia and Mongolia) Advances in Current Natural Sciences 4 43-50 (in Russian)
[5] Kylgydaï A Ch 2014 The demographic situation in the border regions of South Siberia Natsional'nïye Interesы: Prioritet i Bezopasnost 5 54-9 (in Russian)
[6] Zhamyanova Yu B and Osodeev P V 2019 Demographic potential of the Russian-Mongolian border zone within the framework economic corridor China-Mongolia-Russia Advances in Current Natural Sciences 11 70-5 (in Russian)

[7] Vorobyev N V, Emelyanova N V and Rykov P V 2018 The urbanization and development of urban agglomerations in Siberia and North China in the context of the new silk road Problems of Economic Transition 60 8-9 597-613 doi:10.1080 / 10611991.2018.1595830

[8] Violin S I 2018 Development of the transboundary economic cooperation within the China-Mongolia-Russia economic corridor IOP Conf. Series: Earth and Environmental Science 190 012065 doi:10.1088/1755-1315/190/1/012065

[9] Andreev A B and Makarov A V 2019 The routes of the Mongolian economic corridor: development prospects, transport and logistics constraints IOP Conf. Series: Earth and Environmental Science 320 012014 doi:10.1088/1755-1315/320/1/012014

[10] Ecological Atlas of the Lake Baikal Basin 2015 ed V M Plyusnin, A R Batuev and L M Korytyn (Irkutsk: Publishing House V B Sochava Institute of Geography SB RAS) p 145

[11] Elvidge C D et al. 2007 The Nightsat mission concept International Journal of Remote Sensing 28(12) 2645-70 doi:10.1080/01431160600981525

[12] Vorobyev A N 2019 The mapping population in a sparsely populated region: a case study the Irkutsk region IOP Conf. Series: Earth and Environmental Science 381 012095 doi:10.1088 /1755-1315/381/1/012095