Agglomerations of Siberia: formation and problems of development

N V Emelyanova¹, A A Sorokovoi¹, B Dorjgotov² and Yu V Antipina¹

¹Sochava Institute of Geography SB RAS, Russia, Irkutsk
²Institute of Geography and Geoecology, Mongolian Academy of Sciences

E-mail: lesnata84@mail.ru, geomer@irigs.irk.ru, dbattogtokh@gmail.com, juliaav9@mail.ru

Abstract. In the modern world, urbanization processes are becoming more and more intense, and the number of cities and their size are steadily increasing. The specific character of the country is quite well reflected in the geography of Russian cities, i.e. the large dimensions of space, a consistent approach to formation of the State territory, and the course of urbanization. The regions of the RF differ from one another by the degree of development, the level of socio-economic advancement and matureness of the systems of cities, and by the spatial pattern of population distribution. Nowadays, the prospects for formation and development of large urban agglomerations (UAs) of Siberia are generating great interest. The characteristics of development of agglomerations in Siberia are considered. Based on analyzing the demographic processes and the existing population distribution pattern, an assessment is made of the problems and prospects of formation of agglomerations in Siberia.

1. Introduction
The system of population distribution in the Siberian macroregion has a clearly pronounced linear character. The main latitudinal axes, i.e. the Trans-Siberian and South-Siberian railroads, can be highlighted in its as well as the meridional directions along the main Siberian rivers strengthened by transverse railroad lines and motor roads. Major administrative and industrial centers of Siberia: Omsk, Novosibirsk, Krasnoyarsk, Irkutsk, Barnaul, and Novokuznetsk, emerged at the junction of the transit roads and rivers. An advanced system of rural settlements has been established on flat territories along the Transsib and to the south of it. To the north of Transsib and in the mountainous areas of Siberia, settlements have a rare, focal character and are concentrated largely in the zones of extraction of preprocessing of natural resources.

An accelerated urbanization was characteristic for the Siberian regions during the 1930s–1950s resulting in a predominance of the urban population over the rural residents as early as 1959. Over the last 25 years, the growth of the urban population in Siberia, as well as all over Russia, has ceased. The degree of urbanization of the Siberian territories differs significantly from region to region. The rural population exceeds the urban population only in the Altai Republic (70.8% of the rural residents); its share is significant (over 40%) in the Tyva Republic, in the Republic of Buryatia, and in Altai krai. The other regions show a substantial predominance of the urban population living in cities of different socio-economic types; there are also large cities, according to Siberian standards [1, 2].
2. **Objects, data and methods**

The Russian settlement system, including the Siberian system, is currently at the transition to a new phase of urbanized territories, i.e. formation of large urban agglomerations. There are nine large urban agglomerations (henceforth referred to as UAs) in Siberia: the Novosibirsk, Omsk, Krasnoyarsk, Tyumen, Novokuznetsk, Irkutsk, Barnaul, Tomsk and Kemerovo agglomerations. The agglomeration process is also going on around cities of about 100–500 thousand inhabitants. The group of potential emerging UAs includes: the Ulan-Ude, Abakan-Chernogorsk and Chita agglomerations. The emerging agglomerations currently corresponding to one or several criteria of UA identification but not corresponding to the other attributes (Pilyan and Selivanova, 2007) (table 1) can be characterized as potential ones [3, 4].

The list of “small agglomerations” includes (according to E.E. Leizerovich) the Abakan-Minusinsk, Kansk and Achinsk agglomerations [5].

| Urban agglomeration | Cities as part of UA (city-center is highlighted) | Population of UA cities, thou | Share of region’s population, % |
|---------------------|--------------------------------------------------|-----------------------------|--------------------------------|
| **Novosibirsk UA**  | Novosibirsk, Berdsk, Iskitim, Ob                 | 1601.2                      | 65.0                           |
| **Krasnoyarsk UA**  | Krasnoyarsk, Zheleznogorsk, Divnogorsk, Sosnovoborsk | 1063.3                      | 43.5                           |
| **Omsk UA**         | Omsk                                             | 1134.0                      | 59.7                           |
| **Novokuznetsk UA** | Novokuznetsk, Prokopievsk, Kiselevsk, Mezhdurechensk, Osinniki, Myski, Kaltan | 1104.3                      | 39.4                           |
| **Tyumen UA**       | Tyumen, Yalutorovsk, Tyumen district             | 640                         | 24.7                           |
| **Irkutsk UA**      | Irkutsk, Angarsk, Shelekhov, Usolie-Sibirske     | 978.4                       | 40.5                           |
| **Barnaul UA**      | Barnaul, Novoaltaisk                             | 660.7                       | 32.6                           |
| **Tomsk UA**        | Tomsk, Seversk                                   | 596.9                       | 65.6                           |
| **Kemerovo UA**     | Kemerovo, Berezovsky, Topki                      | 564.1                       | 24.1                           |

Note: Official website of the Federal State Statistics Service (RF) 2017 https://www.gks.ru

In the Siberian settings, with extensive spaces and large distances between major cities, agglomerations are becoming particularly in demand. Because of close interaction and close mutual location of the satellite cities, the agglomerations effectively accumulate various industrial, scientific, social-infrastructure, cultural and other facilities cities. And this involves a considerable economic potential. But unlike most of the agglomerations of western Russia, the Siberian agglomerations have an uneven spatial organization. This is due to the linear-nodal system of Siberian population distribution in general. With such a system, the main vectors of development are becoming to be represented by the main economic routes (motor roads and railroads), while secondary directions are developed with a great delay, which leads to the asymmetry.

3. **Results and discussion**

The socio-economic potential of major cities in southern Siberia is experiencing the influence of a powerful transport-geographical factor of development. There is taking place an enhanced polarization.
of the “center-periphery” development in the economic and social contexts. The entire periphery is, in fact, the migration donor for the Siberian “capital cities”. While in the Soviet period the main changes in the urban system had a unidirectional character in the form of urban growth, in the post-Soviet period the changes have become immeasurably complex. The processes of socio-economic development are being enhanced on highly urbanized territories formed by major cities.

One of the directions of the process of development of agglomerations in Siberia is the transformation of the suburban area. An accelerated development of settlement in suburban areas manifests itself in a number of interrelated processes: the growth of satellite settlements, the construction of suburban cottage settlements, the formation of a permanent population in suburban horticultural settlements, and the construction of townhouses and low-rise buildings. All these growing settlements are connected with the city center by a network of roads with year-round automobile transportation. In the cities-centers, the volume of the production functions and the development of the services economy are declining. A number of enterprises (mainly machine-building and light industry) that failed to adapt themselves to the new conditions of a market economy, were liquidated. New jobs have emerged mainly in the service sector of the urban economy.

An analysis of the location of cottage settlements on the suburban territory of the Siberian agglomerations showed that most of the settlements are situated along the railroads and motor roads (according to Dorofeeva) [6]. This corresponds to the linear model of population distribution. For example, because of the proximity of the reservoir to the city in Novosibirsk and Irkutsk, the area of suburban settlement is the coast of reservoirs. In most cases, cottage settlements are located in close proximity to residential areas due to the convenience of using the infrastructure. On the flat territory of the Novosibirsk agglomeration, cottage settlements are distributed more evenly. In the Krasnoyarsk and Irkutsk agglomerations, cottage settlements are located on the territory with favorable flat terrain. Thus the following common features can be identified in the location of the cottage settlements in the agglomerations of Siberia:

- linear arrangement sitting along the transport routes;
- fixation to flat terrain;
- proximity of rural settlements, and
- existence of areas with natural and recreational attractiveness.

The processes of urban renewal and beautification imply a concentration of the main volumes of construction and installation work in the UA centers: most of the housing is constructed and commissioned, and infrastructure facilities are being created. A significant part of production and storage facilities with adjacent territories was reconstructed for trade and services facilities. The centers show a great share for many indicators when compared with the region. For instance, the significance of investment of the centers reaches 80% in Omsk and Novosibirsk: the level of actual unemployment in UAs is significantly lower than in the rest of the territory, and there is an increase in the volume of paid services and retail trade (table 2).

Examination of the concepts of establishing UAs in Siberia (the Novosibirsk, Krasnoyarsk and Irkutsk agglomerations) and approaches to project implementation substantiates the socio-economic preparedness of the territories for development of unification processes of urban entities (figure 1).

An important issue in the development of UAs is the legal status and governance issues. Today, the issue of agglomeration management is open to much debate. The French two-tier model corresponds more to the Russian vertical management system; however, it can also exacerbate the existing serious problems in the municipalities’ management. They include bureaucracy, problems with communication between authorities and citizens, high politicization, and others. Therefore, in the case of the Siberian agglomeration it would logically be best to apply the American one-tier contractual model, which does not require legal unification of municipalities. The unification question was the main stumbling block in the attempt to organize the Irkutsk agglomeration. The "Planning Council" agency should include control over the system of intercity roads and intercity transport, issues of functional and economic development, general agglomeration engineering communications, some important recreational resources, major projects, such as the new airport, etc. [7, 8].

•

•

•

•
Figure 1. Siberian urban agglomerations.

Table 2. Main aspects of Siberian UAs [9-11].

| Main aspects                                      | Novosibirsk UA | Irkutsk UA  | Krasnoyarsk UA |
|--------------------------------------------------|----------------|-------------|----------------|
| Place in the list of the largest Russian UAs     | 6              | 21          | 18             |
| Population density                               | 125 pers/km^2  | 69.7 pers/km^2 | 50 pers/km^2 |
| Rate of migration increase                       | 16%            | 6.6%        | 13.5%          |
| Place of the city-center location in the city’s attractiveness rating | 7              | 45          | 33             |
| Place of the city-center position in the labor attractiveness rating | 27             | 23          | 28             |
| Annual average air emissions                     | 128 500 tons   | 193 200 tons | 233 800 tons   |
| City-center gross urban product of the UAs       | 748 billion rubles | 388 billion rubles | 579 billion rubles |
| Gross urban product per capita                   | 483.2          | 632.3       | 558.8          |
| Contribution of cities to gross regional product | 77%            | 23%         | 33%            |
| Average salary in the city-centers of the UAs    | 28870 rubles   | 32650 rubles | 37097 rubles   |
| Housing commissioned                             | 1 567 087 persons | 620 099 persons | 1 015 420 persons |
| Retail trade turnover                             | 469.4 billion rubles | 131 billion rubles | 502.1 billion rubles |
| Industrial enterprises                            | 37             | 20          | 16             |
| Including large enterprise                       | 11             | 8           | 7              |
| Industrial output for 2017                        | 158.3 billion rubles | 368.1 billion rubles | 130 billion rubles |
Growth rate of industrial production (2017 against 2016): 0.8% 5.7% –1.8%
Museums with a total area over 500 sq. m, including open-air museums: 8 5 4
Volume of tourist flow: 312 thou 560 thou 700 thou
Number of universities: 28 16 30
Best place in the Russian universities rating: 8 81 42
Number of students: 200 000 persons 106 600 persons 96 115 persons

4. Conclusion
The problems of development of urbanized territories, and formation of large urbanized terrains development problems and the large UAs have specific features in Siberia. The main features of the Siberian UAs are the spatial isolation of many cities, underdevelopment of the transport system and expedited industrialization.

The agglomeration processes have a contradictory character. The population concentration in the agglomerations makes it possible to use this factor as a means of socio-cultural and commercial development, because an increase in the population size to a million or more makes these settlements attractive for the arrival of large commercial network structures and investors.

When planning and elaborating agglomerations development strategies, we should also take into account the negative consequences of the agglomeration process. A significant contrast between the highly urbanized objects (cities with over a million population, and oblast and krai centers) and other settlements, which is common to the central part of Russia, also occurs in Siberia. The mass outflow of the most economically mobile population from the regions to major cities has increased significantly over the past decade. This impairs the region’s economic position as well as creating problems for cities receiving migratory flows. The rapidly growing population of some Siberian cities, approaching this level, significantly increases the burden on the housing and communal services and social infrastructure. The large influx of people inevitably reinforces the megacities’ traditional problems of transport, ecology, public safety, etc. The large outflow of economically mobile, young people from regions and, especially, from rural areas, to megacities exacerbates the problems of demography which are of crucial importance to date.

Formation of agglomerations is very important for economic development of Russia and influences its spatial structure transforming groups of mutually attracting settlements to a unified system connected by intense migration of people. Purposeful building of modern agglomerations in Siberia with a high quality of the urban environment will be favorable for a deceleration of the migration drift of local residents to the European part of Russia and attraction of the population from the neighboring former Soviet republics.

Acknowledgments
The reported study was funded by RFBR according to the research project № 19-55-44020

References
[1] Bezrukov L A et al 2011 Assessment of Contemporary Factors in the Development of Cities and Urbanization Changes in Siberia Ed L M Korytny and N V Vorobyev (Novosibirsk: GEO) p 21
[2] Vorobyev N V and Vorobyev A N 2014 Geography of Siberia in the Early 21-st Century Economy and Population vol 3 (Novosibirsk: GEO) p 154
[3] Polyan P M and Selivanova T I 2007 Urban agglomerations of Russia and new evolution tendencies of their network (1989–2002) Izvestia Akademii Nauk: Seria Geographia 5 18–27
[4] Lappo G M, Polyan P M and Selivanova T I 2007 Agglomerations in Russia in the 21st century Vestnik Fonda Regionalnogo Razvitiya Irkutskoi Oblasti 1 45–52
[5] Leizerovich E E 2010 The network of economic microdistricts of Russia. Variant of the year 2008 Regional'nye Issledovaniya 4 14–28
[6] Dorofeeva L A 2016 The development of suburban settlements of the Krasnoyarsk agglomeration Geography and Natural Resources 3 168–74 doi: 10.21782/GiPR0206-1619-2016-3
[7] Makhrova A G 2015 Seasonal suburbanization in regions of Russia Vestnik MGU: Seria Geografiya 4 60–8
[8] Makhrova A G, Nefedova T G and Pallot J 2016 The Specifics and Spatial Structure of Circular Migration in Russia Eurasian Geography and Economics 6 802-18 doi: 10.1080/15387216.2016.1274663
[9] Emelyanova N V, Naprasnikova E V and Sorokovoi A A 2018 The Ecological State of a Large City of Eastern Siberia in the Process of Urbanization Geography and Natural Resources 4 324–31 doi: 10.1134/S1875372818040054
[10] Russian Museums (RF) 2018 Income accessed online on 15 July 2019 via http://www.museum.ru/mus/location.asp?address=%C8%F0%EA%F3%F2%F1%EA
[11] Rating of Higher Educational Institutions of Russia for 2017 (RF) 2019 Income accessed online on 10 June 2019 via http://vuzoteka.ru/%D0%B2%D1%83%D0%B7%D1%8B/%D0%B3%D0%BE%D1%80%D0%BE%D0%B4%D0%B0