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# GEOINFORMATION TECHNOLOGIES IN THE STUDY OF ETHNIC ASPECTS OF URBANIZATION IN RUSSIA

**ABSTRACT.** The paper discusses the use of geoinformation technologies in studies of ethnic aspects of urbanization in Russia. It analyzes the level of urbanization, urbanization transition in ethnic groups, and changes in the geography of population settlement of the country with centrophobic and other methods.

**KEY WORDS:** Geoinformatics, system, urbanization, ethnic processes, urbanization transition, modeling, geography of settlement.

## INTRODUCTION

The transformation of the ethnic structure of the population of the Russian Federation is determined by the course of urbanization, the nature of migration, demographic processes, and other factors. At present, the ethnic factor has often a dominant influence on the socio-political, economic, cultural, and historical processes.

The modern world is a mosaic of different people coexisting with each other. Cities are particularly diverse. As noted by G.M. Lappo, "Cities concentrate much more mixed, in respect to the national origin, population compared to rural areas..." [Lappo, 2005]. Cities are the catalysts for social and ethnic processes.

To effectively address inter-ethnic issues, it is very important to monitor ethnic processes, synthesize knowledge, and integrate it in the

social and state systems [Belozerov 2001]. GIS technology is an important tool in modern geographic studies of ethnic processes.

The problem of ethnic processes in Russia has been addressed by many national scientists: sociologists, ethnologists, and geographers. Many authors, such as L.A. Arutyunyan, V.A. Avksentyev, V.S. Belozerov, P.M. Polyan, V.A. Tishkov, O.I. Vendina, L.L. Rybakov, and other, are well known in this area. Many authors made significant contribution to the area of urban studies: G.M. Lappo, A.I. Treyvish, Ye.N. Pertsik, Yu.L. Pivovarov, R. Popov, N.A. Sluka, and others.

The research presented herein is based on the information contained in the following documents: the State Statistics Committee of the Russian Federation; the State Statistics Committees of the Stavropol Kray, of the Khanty-Mansiysk Autonomous Districts (AD), of the Yamal-Nenets AD, and of the Astrakhan Oblast; and material published in the scientific literature and periodicals. The set of the data used provided for the reliability of the results and assured valid theoretical conclusions.

## RESEARCH METHODS

The creation of a GIS-based monitoring system is the priority goal in the study of ethnic aspects of urbanization in Russia. This system is based on knowledge about ethnic

aspects of urbanization in Russia and other factors affecting the process. The system has specific features of the architecture and of its components [Belozerov, Panin, Cherkasov, 2012]. The main steps of the construction of this GIS application are:

- 1) selection of the logical structure and creation of the spatial geodatabase based of the material collected; preparation of cartographic framework;
- 2) compilation of the geodatabase on the ethnic structure of the population of Russia and its regions;
- 3) construction of the spatial-temporal models of the ethnic dimensions of urbanization in Russia and its regions;
- 4) assessment and monitoring of the ethnic structure at different territorial levels.

Multi-scale monitoring of ethnic processes using geospatial and statistical analysis utilizes geoinformation and mathematical software products and applies them to the information stored in a geodatabase [Butler, 2011]. This approach allows detailed study of ethnic processes, including the ethnic aspects of urbanization.

The software component of our system was based on *ArcGIS Spatial Analyst (ESRI)*. ArcGIS, like other powerful information systems, has a well-defined model for working with data, especially spatial. This product has a number of features that facilitate monitoring of multi-scale ethnic processes; the tools for modeling and mapping of processes have diverse functionality.

A geodatabase (e.g. file or personal) stores spatial and non-spatial data and enables efficient data retrieval. The data stored in the system can be accessed and rendered through geostatistical analysis. Our system utilized vector data formats (polygon, point, and line objects); the data in the database were organized logically and hierarchically, which improved data management because it integrated many different types of geographic

features in a single space while preserving the initial characteristics of its elements. Spatial relationships within this data model were particularly important in solving complex analytical problems (Andrianov, 2004).

Data representation in a vector model is similar to traditional paper maps. Points represent geographic objects that are too small to be shown as lines or polygons; lines represent narrow objects that cannot be shown as polygons; polygons represent closed and homogeneous objects. All geographic objects that make up the spatial component are assigned a unique ID; the associated non-spatial information is stored in the attribute tables of ArcGIS.

A conceptual scheme of the GIS-based monitoring approach that we have developed and that comprehensively reflects features of the ethnic structure of Russia is presented in Fig. 1. The experience of the laboratory "Population and GIS Technologies" of the North Caucasus Federal University was instrumental in the creation of the conceptual schemes of the geoinformation monitoring of ethno-demographic [Panin, 2005] and demographic processes [Rauzhin, 2011]. As any working GIS system, the GIS-monitoring approach described herein includes five key components: hardware, software, data, users, and methods<sup>1</sup>. The spatial objects in our GIS

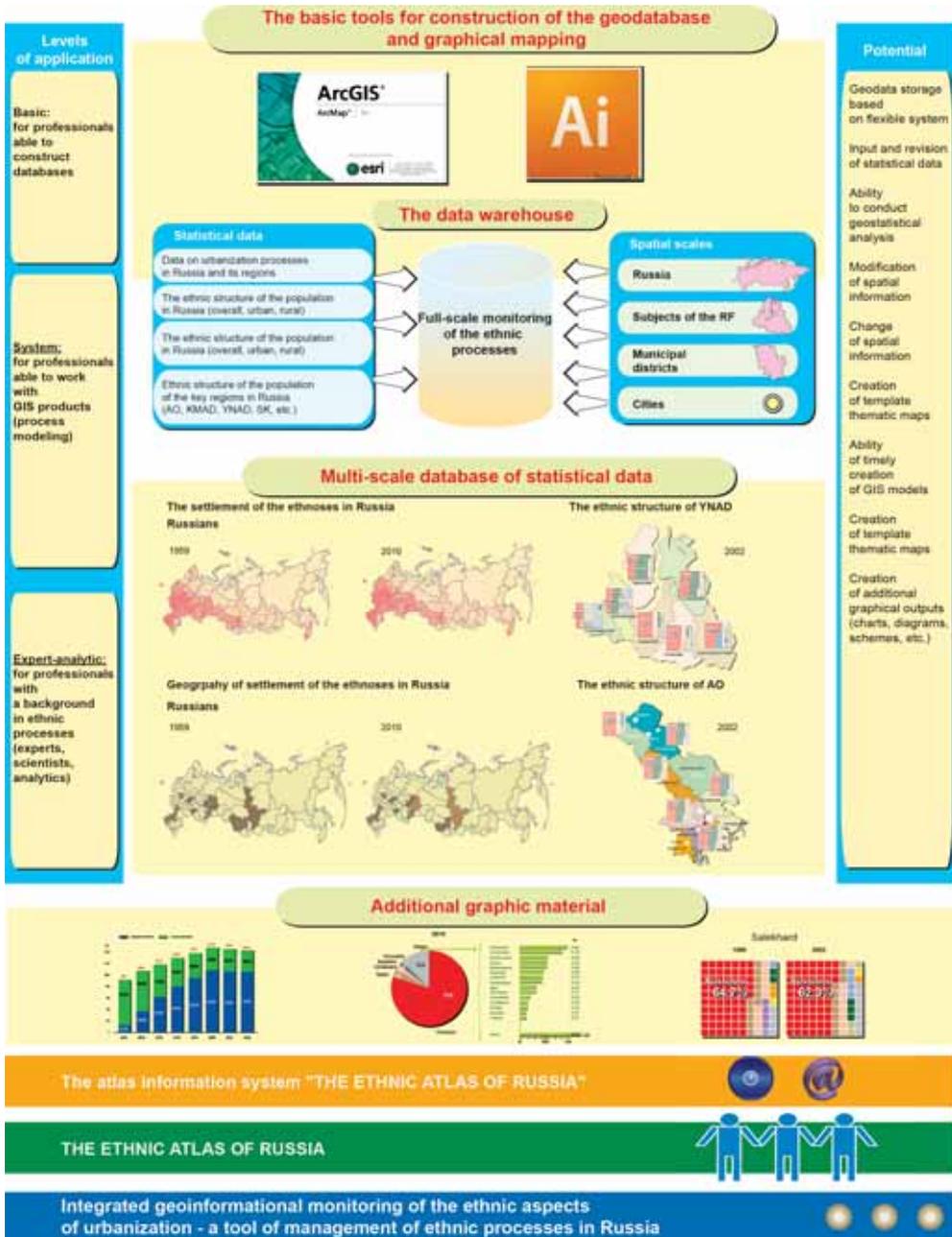
<sup>1</sup> **Hardware:** is a computer that is running GIS. Nowadays, GIS applications work on different types of computing platforms, from centralized servers to separate or connected by a network desktop computers (in our case).

**GIS software:** provides the functions and tools needed to store, analyze, and visualize geographic (spatial) information. Key components of the software are tools for entering and manipulating geographic information, a database management system (DBMS), tools supporting spatial queries, analysis and visualization (maps), and a graphical user interface (GUI) for easy access to tools.

**Data:** is the most important component of GIS. Data on the spatial position (geographical data) associated with tabular data can be collected and prepared by the user, purchased from commercial suppliers, or taken from other sources. In the process of spatial data management, GIS integrates spatial data with other types and sources of data, and can also use DBMS; DBMS is used by many entities to organize and support available data.

**Operators:** wide application of GIS technology is not possible without people who work with software products and design their application for solving real problems. GIS users can be technical experts, developing and maintaining the system, and regular employees (end-users) that use GIS to solve current issues and everyday problems.

**Methods:** the success and effectiveness (including socio-economic) of the GIS application depends on a well-designed plan and work rules prepared in accordance with specific tasks.



**Fig. 1. The conceptual scheme of GIS for monitoring of the ethnic aspects of urbanization in Russia**

approach are tied to the local conditions in the Cartesian coordinate system.

The GIS-monitoring approach for the study of the ethnic dimensions of urbanization in Russia was built on the administrative-territorial division (ATD) of the Russian Federation in 2010, since it is the most useful

for comparing data in the GIS environment for 1959, 1970, 1979, 1989, 2002, and 2010, and allows most consistent analysis.

The cartographic GIS-monitoring approach is based on the territorial structure for the key regions (Astrakhan Oblast [AO], Stavropol Kray [SK], Khanty-Mansi and Yamal-

Nenets ADs [KMAD and YNAD, respectively], Karachai-Cherkess Republic [KChR], Moscow, etc.). The attribute database contains both the original and derived information. The original information includes statistical sources, each with its own characteristics. The statistical forms differ in regularity, consistency formats, parameters, and units of measure. This statement refers to the census data for RSFSR, Russian Federation, AO, SK, KMAD, YNAD, KChR, Moscow, etc.

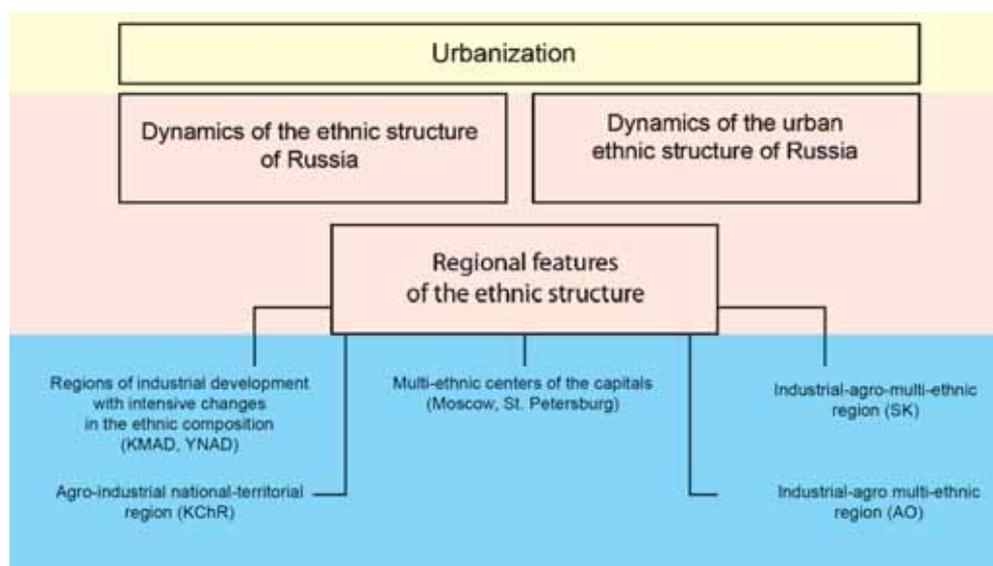
The design of the logical structure required the identification of specific information available. This information defined the selection of its thematic blocks. We identified four blocks, each with a set of two-dimensional tables related to each other on the key fields (Fig. 2).

The blocks "Urbanization", "Dynamics of the ethnic structure of Russia", "Dynamics of the urban ethnic structure of Russia", and "Regional features of the ethnic structure" contain data for Russia and the regions (AO, SK, KChR, KMAD, and YNAD – at the level of cities and administrative districts; and Moscow).

The blocks "Urbanization", "Dynamics of the ethnic structure of Russia", and "Dynamics of the urban ethnic structure of Russia" are

utilized in the GIS-application at different territorial levels of the Russian Federation ATD and provide statistical geodata on the population of the country's regions and the ethnic structure of the population in general and separately for urban areas.

The block "Regional features of the ethnic structure" is the most complex because it includes five additional sub-blocks. Each sub-block addresses a separate region in the research. The following regions were chosen as the study areas: the regions currently industrially developed and with intensive changes in the ethnic structure of the population [KMAD and YNAD], multi-ethnic centers of the capitals (Moscow, St. Petersburg), industrial-agro multi-ethnic regions – SK, AO; and agro-industrial national territorial districts (KChR). This structure of the GIS-monitoring approach determined the thematic divisions that include cartographic components on the ethnic aspects of urbanization in Russia. Table 1 presents the names and content of the blocks of the spatial database. The first three blocks are the cartographic models of the ATD of the Russian Federation (subjects and cities). The first block contains information on the urban network at the time of the censuses



**Fig. 2. The thematic blocks of the attribute GIS database for monitoring of the ethnic aspects of urbanization in Russia**

**Table 1. The structure of the thematic components of the GIS-monitoring approach for studying ethnic aspects of urbanization in Russia**

| Block                                                   | Territorial level              | Level of operation                          | Data                                                                                                         |
|---------------------------------------------------------|--------------------------------|---------------------------------------------|--------------------------------------------------------------------------------------------------------------|
| 1. Urbanization                                         | RF                             | ATD of RF                                   | Urban network 1897–2010, Number of agglomerations 1897–2010, Number of population, share of urban population |
| 2. Dynamics of the ethnic structure of Russia           | RF Regions                     | ATD of RF                                   | Ethnic structure of population, Ethnic structure of urban population (1959–2010)                             |
| 3. Dynamics of the ethnic structure of cities           | West Siberia KMAD, YNAD        | ATD of KMAD, YNAD                           | Ethnic structure of population of regions, Ethnic structure of urban population of regions                   |
| 4. Regional features of the population ethnic structure | Territories of studied regions | ATD of cities, municipal districts, cities  | Ethnic structure of population of regions, Ethnic structure of urban population of regions                   |
| 4.1. Currently industrially developed regions           | KMAD, YNAD                     | ATD of these regions, cities, and districts | Ethnic structure of population, Ethnic structure of urban population (1959–2010)                             |
| 4.2. Multi-ethnic centers of the capitals               | Moscow, St. Petersburg         | City                                        | Ethnic structure of urban population of regions (1959–2010)                                                  |
| 4.3 Multi-ethnic industrial-agro regions                | SK                             | ATD of regions, cities, and districts       | Ethnic structure of population, Ethnic structure of urban population, (1959–2010)                            |
| 4.4. Multi-ethnic industrial-agro regions               | AO                             | ATD of regions, cities, and districts       | Ethnic structure of population, Ethnic structure of urban population, (1959–2010)                            |
| 4.5. Agro-industrial national territorial district      | KChR                           | ATD of regions, cities, and districts       | Ethnic structure of population, Ethnic structure of urban population (1959–2010)                             |

and the share of the urban population in the regions. The next two blocks reflect the ethnic structure of the population in Russia, especially the ethnic structure of urban population and its regional features. The fourth thematic block includes the cartographic basis of the ATD of the regions under study (the ethnic structure of the population in these regions, especially the ethnic structure of the urban population).

## ANALYSIS OF THE RESULTS

The use of this GIS-monitoring application enabled a comprehensive analysis of the ethnic aspects of urbanization in Russia. Based on the quantitative characteristics of the ethnic aspects of urbanization, we have developed a typology of ethnic groups in terms of the urbanization features and urbanization transition. This typology makes it possible to analyze the participation of different regions of Russia in the process of urbanization.

The overall urbanization transition in Russia occurred in 1958 [Popov, 2005]. Each of the ethnoses participated, to a greater or lesser extent, in rapid urbanization of the territory of modern Russia in the XX<sup>th</sup>–XXI<sup>th</sup> centuries.

By the nature of participation in the urbanization process, the ethnoses may be divided into the following groups:

- **ethnoses with early urbanization transition that was recorded in the 1959 census or earlier** (Russians, Ukrainians, Belarusians, Georgians, Uzbeks, Armenians, Moldavians, Azerbaijanis, Latvians, and Lithuanians);
- **ethnoses, whose urbanization transition was recorded in the censuses of 1970 and 1979** (Ossetians, Tatars, Laks, Balkars, and Germans);
- **ethnoses with late urbanization transition recorded in the censuses of 1989,**

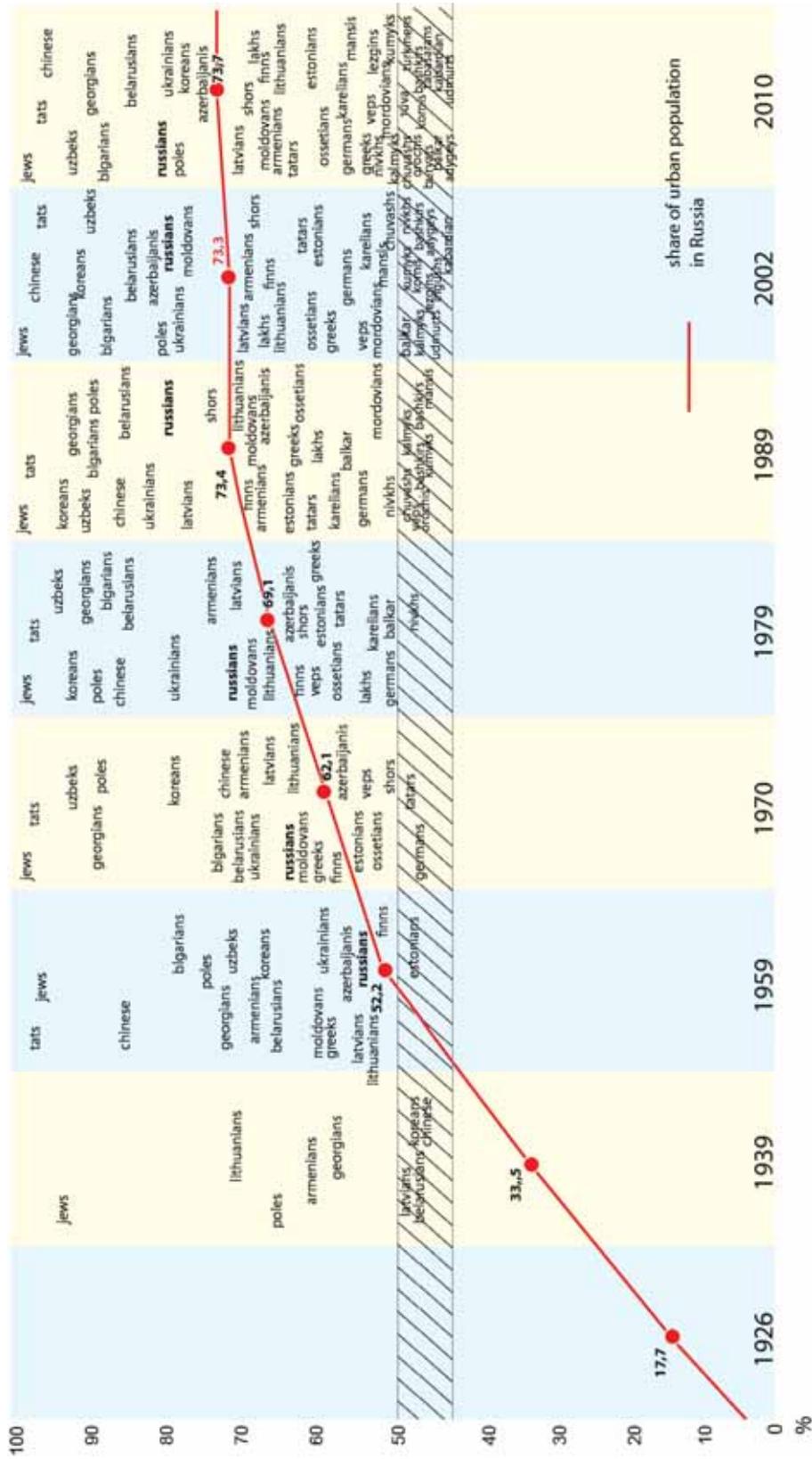


Fig. 3. The level of urbanization and the urbanization transition of the ethnoses in Russia

**2002, and 2010** (Mordovians, Lezghins, Kumyks, and Kalmyks);

– **ethnoses with the failed transition to urbanization in 2010:**

a) **ethnoses approaching the transition to urbanization – urban population ranges from 45,1 to 49,9%** (Adyghees, Kabardians, Udmurts, Buryats, and Bashkirs);

b) **ethnoses with 45,0% share of the urban population** (Maris, Ingushs, Chechens, Dargins, etc.) [Belozerov, Cherkasov, 2012].

Analysis of the quantitative characteristics of the ethnic dimensions of urbanization revealed differences in urbanization level of the individual ethnoses in Russia (Fig. 3). Due to different historical and socio-economic factors, some ethnoses were included in the orbit of urban life earlier than others. However, the trend toward a greater involvement in urbanization processes was common to all groups. Overall, based on this typology, it is possible to state that urbanization in Russia was occurring with a phase-gate inclusion of the ethnoses in urbanization processes [Cherkasov, 2011]. Currently, the share of the ethnoses in Group I is 81,5% of the population. Together with Groups II and III, the people who underwent urbanization transition comprise 87,9% of the population of Russia.

The spatial-temporal and mathematical modeling is one of the key aspects of monitoring of the ethnic aspects of urbanization in Russia [Tikunov, 1997]. In the study, we used the centrographic method [Polian, Treyvish, 1990]. This method allows not only assessing whether the ethnoses living in the territory of Russia are in the state of “balance” or “imbalance”, but also identifying the displacement vector of the center of gravity of the population groups that have different intensity of changes in geography of settlement. The following groups were identified with this approach:

– ethnoses with changing, over a long period of time, geography of settlement

(Russians, Jews, Belarusians, Ukrainians, and Germans);

– ethnoses with rapidly changing, in the last decades, geography of settlement (Avars, Chechens, Armenians, and Azerbaijanis);

– ethnoses with a relatively stable center of gravity of the population (Tatars, Kazakhs, and Bashkirs). (Fig. 4).

Currently, the share of the urban population of the ethnoses with changing geography of settlement is high; all of them have undergone urbanization transition. In the ethnoses with rapidly changing, in the last decades, settlement geography, Armenians and Azerbaijanis comprise a high proportion of the urban population as they underwent urbanization transition in the early stages of urbanization. At the same time, Avars and Chechens have not yet completed the urbanization transition. The ethnoses with a relatively stable center of gravity of the population have a low share of the urban population; they have not yet undergone the urbanization transition.

Let us consider the center of gravity of settlement for Russians, as the ethnic group with settlement geography changing over time. The largest shift of the center of gravity of the Russian settlement to the east of the country took place in 1959–1970. The center of settlement shifted to the north-west of the Orenburg region on the territory of the Republic of Bashkortostan (the western part of the region) and, then, the shift to the east continued until 1989, when the center of the Russian settlement reached the central part of the country. After 1989, the center of gravity has changed its vector from the east to the west. Between 1989 and 2002, there was a shift to the west; the center of gravity of the Russian settlement in 2002 coincided with that in 1979. By 2010, the center moved to the level of 1970. These trends are supported by other models; thus, the point method showed the same trends in the distribution of the Russian population: a shift eastward until 1989 and to the west in the subsequent years.

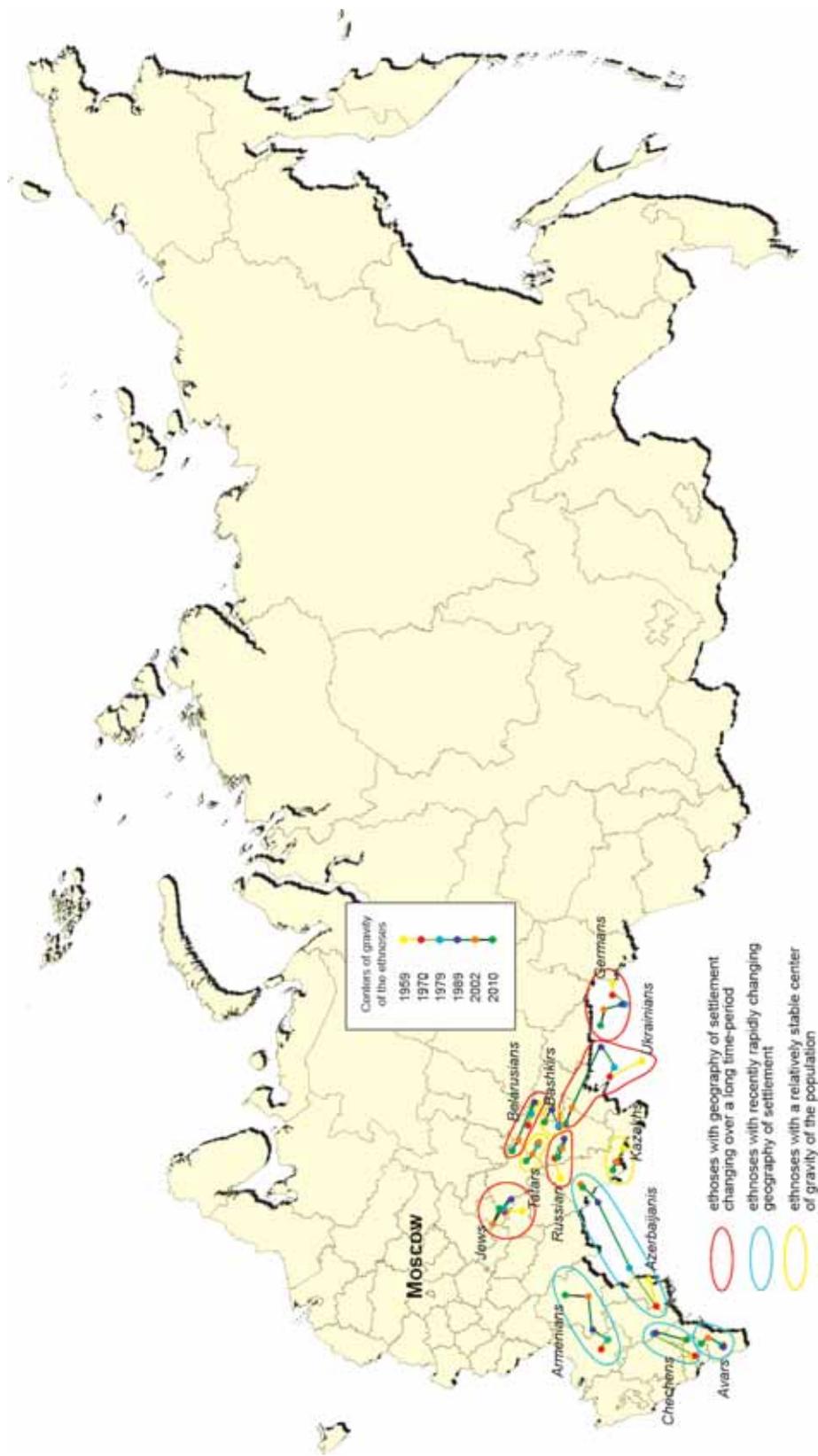


Fig. 4. The centers of gravity of the population settlement in Russia, 1959–2010

Ukrainians, for a long time, have also been included in the group of ethnoses with changing geography of settlement. This ethnos has had a significant shift in the center of gravity of settlement. From 1959 to 1970, the center moved to the north-west and stopped at the eastern border of the Chelyabinsk region in Kazakhstan. From 1970 to 1989, the center of gravity was moving east into the territory of Kazakhstan. After 1989, the center of gravity changed its vector to the north-west; during this time, its direction changed significantly and, in 2002, it moved to the boundary of the Chelyabinsk Region and the Republic of Bashkortostan. In the subsequent period, the trend continued and, in 2010, the center of gravity of settlement of Ukrainians in Russia was located in the central part of the Republic of Bashkortostan.

The titular ethnoses of the former Soviet Union Transcaucasus republics have a rapidly changing, in the last decades, geography of settlement. For example, the center of gravity of Azerbaijanis underwent rapid change in the geography of settlement to the north-east of the country: in 1959–1970, there was a shift of the center of gravity of Azerbaijanis from the east of the Astrakhan region to its south-western part; in 1970–2002, the direction changed to the north-east and the center moved to the north-western part of the Orenburg region. In 2002–2010, the center of gravity reached certain equilibrium and remained almost at the same level with only a slight shift to the south-west.

Armenians also belong to the ethnoses with a rapidly changing, in the last decade, geography of settlement. The censuses of 1959, 1970, and 1979 indicate a consistent

position of the center of gravity in the south-eastern part of the Rostov oblast. After 1979, the center of gravity of the Armenian settlement began to shift rapidly in the north-eastern direction. In 1989, the center was located in the south-western part of the Volgograd Oblast; in 2002 it moved to the central part; and in 2010, it was in the northern part of the oblast.

## CONCLUSIONS

Geographic information technologies present a great opportunity for the use of mathematical methods in the construction of cartographic models; GIS provides for the flexibility to quickly update data as new statistics appears. This approach to the monitoring of the ethnic dimensions of urbanization in Russia allowed grouping the ethnic groups by their participation in the urbanization processes, modeling of the centers of gravity of the population with the centrographic method, and, with the method of settlement distribution modeling, analyzing the settlement patterns of the peoples of Russia.

The prospects for further research include creation of a unified specialized geographic information system for monitoring of the ethnic processes in Russia. This system would provide analytical support to decision-making aimed at regulation and stabilization of the inter-ethnic, ethno-demographic, and migration processes in the Russian Federation.

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