DOI: 10.15838/ptd.2025.6.140.10
UDC 314.8:314.9 | LBC 60.723


# DEMOGRAPHIC POTENTIAL OF TERRITORIES: ASSESSMENT APPROACHES AND MEASUREMENT EXPERIENCE

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*In the context of pronounced regional differentiation of Russia's demographic development, an urgent area of research is the working out of a scientifically based methodological approach to assessing the demographic potential of territories to ensure competent management of their development. The aim of the research is to systematize theoretical and methodological approaches to the study of the demographic potential of territories, to work out and test methods for its assessment at the regional level. The paper considers the approaches to the essence and structure of demographic potential, analyzes the indicators used in Russian and foreign scientific research to study the demographic potential of territories, and systematizes the methods of its assessment. The research shows that the use of several methods allows a comprehensive assessment of its condition and dynamics. An index methodology for assessing the demographic potential of territories is presented, and the calculation of two integral indices is proposed – quantitative and qualitative demographic potential (QuanDPI and QualDPI). At the first stage, a set of indicators was formed for the construction of indices (a priori and a posteriori), at the second stage, their calculation was performed. The principal component method is chosen as the method of convolution of private variables into integral indices. The index methodology was tested in Russia's regions for the time period from 2019 to 2023. The information base was compiled by Rosstat statistics. Based on the calculation results, the leading and outsider regions were identified for each index. The grouping of*

**For citation:** Korolenko A.V. (2025). Demographic potential of territories: Assessment approaches and measurement experience. *Problems of Territory's Development*, 29(6), 169–191. DOI: 10.15838/ptd.2025.6.140.10

*regions by the size of the QuanDPI and QualDPI made it possible to construct index ratio matrices. The conducted research has confirmed the close relationship between the quantitative and qualitative components of the demographic potential of the territories.*

*Demographic potential of territories, quantitative and qualitative components, index methodology, grouping, regions of Russia.*

**Introduction**

Demographic potential is an integral component of human potential, therefore, its study serves as a conceptual basis for understanding the nature and drivers of human potential reproduction, as well as developing new mechanisms for its management.

The current stage of Russia's socio-economic development is characterized by a combination of predictable natural demographic challenges (demographic decline, depopulation, and population aging) with new effects for the demographic situation caused by the shock and upheavals of recent years (coronavirus pandemic, special military operation, international sanctions, and changes in the migration policy of the Russian Federation). The uneven spatial development of the country, expressed in the compression and fragmentation of the developed space, creates additional demographic threats, for example, more pronounced depopulation and aging of remote territories due to centripetal migration. These problems hinder the accumulation and disclosure of the demographic and, as a result, the human potential of the country.

The research results confirm that Russian regions differ significantly in the nature of the demographic situation and population reproduction. Thus, O.L. Rybakovsky's grouping of the constituent entities of the Russian Federation according to the relative level of reproduction and its constituent factors showed that depopulation has been observed in most of them throughout the modern history of Russia, namely the previous 33 years, nevertheless, the regions are noticeably differentiated – from the most demographically disadvantaged to those teetering on the brink of depopulation and natural growth. Natural population growth during this period was observed in only 15 regions (Rybakovsky, 2024). In addition, studies show a significant variation in the RF constituent entities in certain indicators characterizing demographic potential: birth rate (Arkhangelskiy et al., 2023), mortality and life expectancy (Rodionova, Kopnova, 2020; Korolenko, 2020), age structure (Rybakovskii, Fadeeva, 2022), internal and external migration (Matraeva, 2024; Smirnov, 2024). As a result, a differentiated approach should be applied to the development of state demographic policy measures, taking into account the regional specifics of demographic potential.

Scientific research has not yet developed a unified theoretical approach to understanding the essence and structure of demographic potential, as well as a methodological approach to measuring it. Some researchers try to define it and associate it with related concepts, others select indicators for its assessment, and others, using this term only in the titles of their works, continue conducting routine demographic analysis (Rybakovskii, 2023). Thus, the issues of developing and improving the theory and methodology of studying the demographic potential of territories are still relevant, in particular, the development of scientifically sound methods for assessing it to monitor the demographic situation and ensure competent management of territorial development.

The aim of our research is to systematize theoretical and methodological approaches to the study of the demographic potential of territories, to develop and test methods for its assessment at the regional level. In particular, we set the following tasks: to review approaches to the interpretation of the concept of "demographic potential", its structure and indicators used for analysis; to systematize methodological approaches to assessing the demographic potential of territories, as well as methods for measuring it; to develop own methodology for assessing the demographic potential of territories and to test it in Russia's regions.

The study is based on two hypotheses:

1) a methodology for measuring the demographic potential of territories, taking into account its quantitative and qualitative characteristics, provides a more reliable and complete assessment of the situation compared to approaches based only on quantitative indicators, and allows identifying problems specific to particular regions, carrying out their multidimensional typology, which is important for determining the priorities of demographic policy;

2) Russian regions are markedly differentiated in terms of quantitative and qualitative indicators of demographic potential, as well as their ratio.

The scientific novelty of the research lies in the development of a new methodology for assessing the demographic potential of territories, taking into account its quantitative and qualitative components and applicable at the level of the constituent entities of the Russian Federation.

The information base consists of scientific publications on the research topic and Rosstat official statistics.

## Theoretical and methodological aspects of the study

The term "demographic potential" appeared in the scientific literature at the end of the 20th century and found application mainly in the works of researchers from Eastern Europe and Russia (Korolenko, 2021). It is actively used in their works by scientists from Poland (Sojka, 2012; Pastuszka, 2017; Gwiazdzińska-Goraj et al., 2020), Slovakia (Koišová et al., 2021), Serbia (Stojanović et al., 2017), Bulgaria (Mladenov, 2016), Georgia (Sobczyk, Archuadze, 2016). In Russia, S.A. Sukneva (Sukneva, 2010), V.V. Fauser (Fauser, 2014), O.L. Rybakovskii and O.A. Tayunova (Rybakovskii, Tayunova, 2019; Rybakovskii, 2023), N.K. Gabdrakhmanov (Gabdrakhmanov et al., 2014) etc. Demographic potential studies are conducted at different levels: cross-country and national (Sojka, 2012; Pastuszka, 2017), regional (Sukneva, 2010; Trifonova et al., 2010; Kornienko, 2014; Fauzer, 2014; Kalugina et al., 2015; Shubat et al., 2019; Dobrokhleb, Sigareva, 2019; Gwiazdzińska-Goraj et al., 2020; Koišová et al., 2021) and municipal (Bessmertnyi et al., 2021; Korolenko, 2021; Gabdrakhmanov et al., 2014; Sobczyk, Archuadze, 2016; Mladenov, 2016; Stojanović et al., 2017).

To understand the essence of the category "demographic potential" and to change approaches to its interpretation, let us focus a little on the development of the demographic potential concept. First of all, the content of the term "demographic potential" has changed from its narrower interpretation as "life potential" (L. Hersh, J. Bourgeois-Pich, E. Filrose), "reproductive potential" (R. Fischer), "growth potential" (P. Vincent), "migration potential" (J. Stewart, J. Zipf), "potential of the settlement field" (O.A. Evteev, S.A. Kovalev) to its modern interpretation – common demographic resources, opportunities and reserves. Each of these categories affects particular resources for the reproduction and maintenance of the population in the territory (vital, reproductive, migration, opportunities for population growth and settlement). In addition, during the development of this scientific

field, the research subject naturally changed: from the study of individual components of demographic potential (number, fertility, mortality, migration, population structure) to its generalized indicators.

Currently, there is still no universal definition of the concept of "demographic potential" in the demographic literature. There are several basic approaches to interpreting it from the perspective of content: as a component of human potential (its basis, a condition for its formation and functioning); as the ability of the population to reproduce; as a generalized characteristic of the demographic situation; as available resources, opportunities, reserves of demographic development. The majority of definitions come down to the population of a given territory and its ability to reproduce (Korolenko, 2021). There are narrow and broad interpretations of this concept: in a narrow sense, it is understood as the potential for population reproduction, including the potential for changes in fertility and mortality, and in a broad sense, the potential for general population movement (population reproduction potential, and migration potential), including possible changes in the number and structure of the population due to fertility, mortality, emigration, and immigration (Rybakovskii, Tayunova, 2019).

As O.L. Rybakovskii and co-authors note, demographic potential is an instrumental and synthetic term, therefore it can combine both all and individual population possibilities of a particular territory. This concept is generalizing, combining the potential in various fields of demography (Rybakovskii, Tayunova, 2019; Rybakovskii, 2023). The scientist conditionally divides it into three components according to its functionality: demographic resources (funds, reserves), and/or demographic opportunities (current and prospective), and/or (additional) demographic reserves (Rybakovskii, 2023):

– *demographic resources* are what is available at a given time, i.e. number and demographic structure of a particular territory and beyond (in the case of migration) – in migration-related territories;

– *demographic opportunities* are the levels of intensity of demographic processes in a territory calculated over a period of time and their expected and anticipated demographic consequences, such as changes in demographic structures;

– *demographic reserves* are prospective possible deviations of the intensity levels of demographic processes in a territory and their expected demographic consequences from "long-term inert" trends under the influence of demographic policy measures, external and internal socio-economic, political and other factors.

At the same time, we can put a different number of components into the concept: in the minimum form – one of three, in the average version – two of three, in the extended version – all three (Rybakovskii, 2023).

Along with the category "demographic potential", it is also used the concepts of "socio-demographic potential" (Kalugina et al., 2015; Koišova et al., 2021) and "geodemographic potential" (Gabdrakhmanov et al., 2014). The first term, in addition to the demographic component of the potential, considers the social component, which mainly characterizes the level of education, employment and well-being of the population. The term "geodemographic potential" is mainly used as a synonym for the demographic potential of territories.

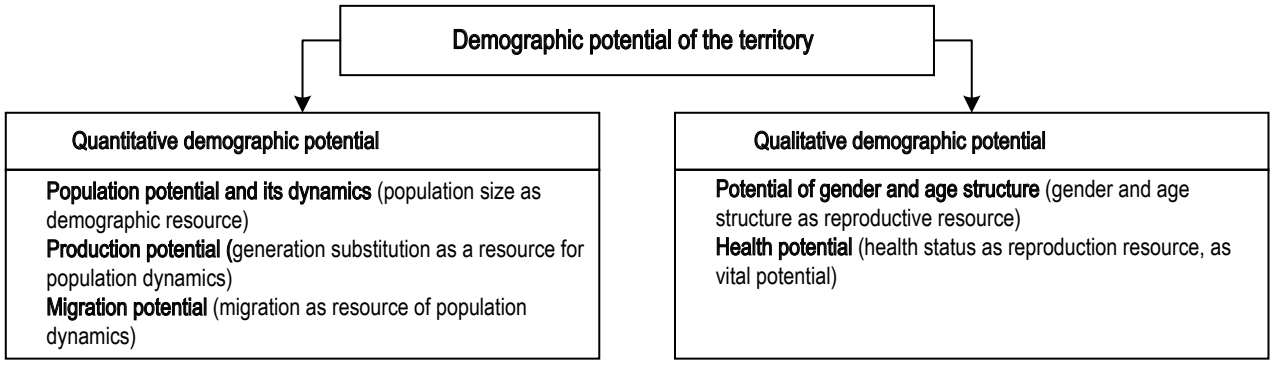
Our study understands the demographic potential of the territory as a demographic resource, expressed in the characteristics of the population and the components of its dynamics, reproduction and migration, demographic structures and qualitative parameters of the population, which are able to ensure a positive demographic dynamic of the territory. At the

same time, the demographic potential is not limited to a quantitative demographic resource (population size and its distribution over the territory, natural and migration movement), but also reflects the population's ability to reproduce (generational change as a result of the ratio of fertility and mortality), since its regime directly determines the nature of population dynamics. In turn, the ability to reproduce depends on the age and gender structure and the quality of its health.

Approaches to the structure of demographic potential also vary. For example, O.L. Rybakovskii identifies two main parts – reproductive and migration potentials. Each of them has two components: the first is the potential for changes in the intensity of age-related fertility and the potential for changes in the intensity of age-related mortality, while the second is the potential for changes in the intensity of permanent arrivals and the potential for changes in the intensity of permanent departures (Rybakovskii, 2023). M. Gwiazdzińska-Goraj and colleagues identify four components of quantitative demographic potential: population size, population distribution by territory (density), population structure by age, population structure by gender. They consider the natural and migration movement inseparably from the demographic potential, but as its factors (Gwiazdzińska-Goraj et al., 2020). S.A. Sukneva equates demographic potential with reproductive potential and designates three components of its formation – population size, demographic structure and demographic behavior (Sukneva, 2010).

A number of researchers[1] (Smirennikova et al., 2018; Shubat et al., 2019) suggest separating its quantitative and qualitative characteristics when studying the demographic potential of territories. However, the approaches to their content differ. In some cases, quantitative parameters are considered as derivatives of population size and its dynamics, while qualitative parameters are considered as indicators of population structure and composition[2]. Others attribute qualitative aspects to population health, education, ethnocultural and religious composition, and demographic attitudes (Smirennikova et al., 2018). Some scientists equate the qualitative parameters of demographic potential with the quality of the population and include the development level of total human capital, which is determined by the state of health, education, culture, and the moral and ethical sphere (Shubat et al., 2019).

Our research identified two components in the structure of demographic potential – quantitative and qualitative *(Fig.)*. The quantitative component of demographic




**Structure of the demographic potential of the territory**

Source: own compilation.

[1] Ryazantsev S.V., Aidrus I.A., Pis'mennaya E.V. (2008). Demographic potential as a basis for the development of the higher education system: Textbook. Moscow: RUDN. 258 p.

[2] Ibidem. P. 5, 9.

potential (quantitative potential) reflects the quantitative human resource of a territory, the ability to reproduce and maintain its population. Accordingly, it includes the potentials of population size and its dynamics, reproduction and migration. The qualitative component (qualitative demographic potential) represents both the potential of demographic structures (mainly gender and age) and the potential of public health (as a reproductive resource, the ability to preserve life).

Since researchers identify different structural components of demographic potential, as a result, different sets of indicators are used to analyze it *(Tab. 1)*. In some cases, it is considered only from the perspective of population size and

**Table 1. Indicators used in Russian and foreign scientific research to analyze demographic potential**

| Researcher | Indicators of spatial distribution of the population | Population indicator and its dynamics: | | | | | | | Marriage and divorce rates | Indicator of demographic and other structures: | | | | | Health indicators | Demographic behavior indicators | Other indicators |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Population size and/or its dynamics | Birth rate | Mortality rate | Natural increase /decrease | Reproduction | Migration growth/decrease | Total growth | | Age structure | Gender structure | Marriage and family structure | Ethnic structure | Educational structures | | | |
| Simagin Yu.A. | + | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| Dobrokhleb V.G., Sigareva E.P. | - | + | + | + | + | + | + | - | - | - | - | - | - | - | - | - | + |
| Kornienko O.S. | - | + | - | - | + | - | + | - | - | - | - | - | - | - | - | - | + |
| Fauzer V.V. | - | + | + | + | + | + | + | + | - | + | - | - | - | - | - | - | - |
| Pastuszka S. | - | + | + | - | + | + | + | + | - | + | - | - | - | - | - | - | - |
| Gwiaździńska-Goraj M. et al. | + | + | - | - | + | - | + | - | - | + | - | - | - | - | - | - | - |
| Mladenov C. | + | + | + | + | + | - | + | - | - | + | - | - | - | | - | - | - |
| Sobczyk A., Archuadze Z. | - | + | + | - | - | + | + | - | - | + | - | - | - | - | - | - | - |
| Bessmertnyi I.V. and coauthors | - | + | - | - | + | - | + | - | - | + | - | - | - | - | - | - | + |
| Sojka E. | - | + | + | + | + | + | + | + | - | + | - | - | - | - | + | - | - |
| Trifonova Z.A. and coauthors | - | + | + | - | - | - | + | - | + | + | - | - | - | - | + | - | - |
| Yarnykh E.A., Konstantinova A.G. | - | - | + | - | - | + | - | - | - | + | | - | | - | + | - | + |
| Korolenko A.V. | - | + | + | + | + | - | + | + | - | + | - | - | - | - | + | + | - |
| Stojanović J. et al. | - | + | | | + | - | + | - | - | + | - | - | - | + | - | - | + |
| Kalugina Z.I. and coauthors | | - | - | + | - | - | + | - | - | + | - | - | - | + | + | - | - |
| Koišová E. et al. | - | - | + | + | - | + | - | - | - | + | - | - | - | + | - | - | + |
| Shubat O.M. and coauthors | - | - | + | - | - | + | - | - | - | + | - | - | - | + | + | + | + |
| Sukneva S.A. | - | + | + | + | + | + | + | - | - | + | | + | + | - | - | + | - |
| Gabdrakhmanov N.K. et al. | + | + | + | + | + | + | + | + | + | + | + | - | + | + | + | - | + |

According to: (Trifonova et al., 2010; Sukneva, 2010; Simagin, 2013; Kornienko, 2014; Fauzer, 2014; Kalugina et al., 2015; Dobrokhleb, Sigareva, 2019; Shubat et al., 2019; Bessmertnyi et al., 2021; Korolenko, 2021; Sojka, 2012; Gabdrakhmanov et al., 2014; Mladenov, 2016; Sobczyk, Archuadze, 2016; Pastuszka, 2017; Stojanović et al., 2017; Gwiaździńska-Goraj et al., 2020; Koišová et al., 2021).

spatial distribution (Simagin, 2013), but more often researchers are not limited to population size alone, analyzing its components dynamics: indicators of natural movement and migration, as well as reproduction characteristics (most often the total fertility rate). In addition to the above, indicators of demographic structures are used in other works: age, gender (or age and gender) (Fauzer, 2014; Mladenov, 2016; Sobczyk, Archuadze, 2016; Pastuszka, 2017; Stojanovich et al., 2017; Gwiazdzińska-Goraj et al., 2020), marital and family (Sukneva, 2010) and non-demographic structures: ethnic (Sukneva, 2010; Gabdrakhmanov et al., 2014), educational (Kalugina et al., 2015; Stojanovich et al., 2017; Shubat et al., 2019; Koišova et al., 2021). Marriage and divorce rates are less commonly used as criteria for assessing demographic potential (Trifonova et al., 2010; Gabdrakhmanov et al., 2014).

A number of studies of the demographic potential of territories rely on an expanded set of indicators, both quantitative: population size, rates and components of its dynamics, and qualitative: demographic and non-demographic structures, health, demographic behavior of the population (Trifonova et al., 2010; Sojka, 2012; Gabdrakhmanov et al., 2014; Yarnykh, Konstantinova, 2017; Korolenko, 2021). In addition, in some studies, in addition to the above indicators, characteristics that go beyond the components of population size and reproduction are used, such as the number of abortions (Dobrokhleb, Sigareva, 2019), the ratio of monetary incomes to the subsistence level (Kornienko, 2014), the share of the economically active population (Stojanovich et al., 2017), the number of employed people (Bessmertny et al., 2021), the quality of life index (Yarnykh, Konstantinova, 2017), the employment rate, as well as long-term unemployment and income (Gabdrakhmanov et al., 2014; Koišova et al., 2021), the decriminalization of the region (Shubat et al., 2019), the distribution of labor resources by industry, the cost of industrial products per capita, the average monthly nominal wage of employees, the average growth rate of gross wages (Gabdrakhmanov et al., 2014). It seems that such indicators are rather superfluous and more characterize the factors concerning demographic potential or other related potentials, for example, educational.

A number of methodological approaches to assessing the demographic potential of territories have been developed *(Tab. 2)*. The main ones include statistical-descriptive and criterion-statistical (indicative), while the auxiliary ones include typological and geospatial. Within the framework of the statistical and descriptive approach, the method of analyzing demographic indicators and their dynamics is most often used, while the point-rating and index methods are used within the framework of the indicative approach. The main disadvantage of the methodology for analyzing demographic indicators and their dynamics is the lack of a generalizing characteristic of demographic potential, the inability to compare territories by its level. The point-rating method partially compensates for this disadvantage by providing an opportunity to compare territories by individual parameters of demographic potential by compiling ratings summarized for each indicator. However, it also does not provide general ideas about the state of the demographic potential of the territory. In addition, its limitation is the lack of weights of the compared indicators (Rybakovskii, 2008). This problem is solved by the index method, which allows combining individual characteristics of demographic potential into one integral indicator. Data aggregation during index construction helps to present relevant information and simplify the analysis of complex and voluminous data (Pavlova et

**Table 2. Methodological approaches and methods for assessing the demographic potential of territories**

| Approach | Method | Essence | Researcher |
|---|---|---|---|
| Main (basic) approaches and methods | | | |
| Statistical and descriptive | Analysis of demographic indicators and their dynamics | Analysis of the state and dynamics of individual indicators characterizing demographic potential | S.A. Sukneva, E. Sojka, V.V. Fauzer, J. Stojanović et al., S. Pastuszka, V.G. Dobrokhleb, E.P. Sigareva, A.V. Korolenko |
| Criterion-statistical (indicative) | Point-rating method (point ratings + ranking) | Ranking of demographic indicators on a 5-point scale. Calculating the average score of demographic potential | O.S. Kornienko, I.V. Bessmertnyi et al., E.V. Smirennikova et al. |
| | Index method | Calculation of an integral (synthetic) indicator of the demographic potential of territories, consisting of particular demographic indicators | Z.A. Trifonova et al., A. Sobczyk, Z. Archuadze, E.A. Yarnykh, A.G. Konstantinova, M. Gwiaździńska-Goraj et al., E.V. Smirennikova et al. |
| Auxiliary approaches and methods | | | |
| Typological | Grouping (classification) | Distribution of territories according to the value of the indicator (indicators) of demographic potential | Z.A. Trifonova et al., Yu.A. Simagin, O.S. Kornienko, N.K. Gabdrakhmanov et al., M.Gwiaździńska-Goraj et al., E.V. Smirennikova et al. |
| | Clusterization (cluster analysis) | Identification of clusters of regions (territories) according to indicators of demographic potential | Kalugina Z.I. et al., Koišová E. et al. |
| | Multidimensional classification (a combination of fuzzy clustering with expert estimates) | Identification of territorial models of the demographic potential of the territories of the RF through fuzzy clustering of the RF regions, subsequent expert assessments of clusters to determine the degree of belonging of regions to a specific cluster | O.M. Shubat et al. |
| Geospatial | Cartographic method (socio-demographic mapping) | Mapping territories using demographic potential indicators | C. Mladenov, J. Stojanović et al., I.V Bessmertnyi et al. |

According to: (Sukneva, 2010; Trifonova et al., 2010; Simagin, 2013; Fauzer, 2014; Kalugina et al., 2015; Yarnykh, Konstantinova, 2017; Dobrokhleb, Sigareva, 2019; Shubat et al., 2019; Korolenko, 2021; Bessmertnyi et al., 2021; Smirennikova et al., 2021; Sojka, 2012; Gabdrakhmanov et al., 2014; Sobczyk, Archuadze, 2016; Mladenov, 2016; Stojanović et al., 2017; Pastuszka, 2017; Gwiaździńska-Goraj et al., 2020; Koišová et al., 2021).

al., 2018). At the same time, various methods can be used to construct the index – expert, a priori, multidimensional classification, factor analysis (Frenkel et al., 2015). The main limitation of index methods lies in their methodology itself: they measure exactly what their developers put into them (Pavlova et al., 2018). Their disadvantages also include the problems of determining the composition of particular criteria, correlation of variables, loss of information during convolution, and the opacity of the development process (Pavlova et al., 2018).

Auxiliary approaches and methods are usually based on the results of the application of the basic ones and complement them. The typological approach in research practice is implemented through the methods of grouping, clustering and multidimensional classification. With their help, objects (territories) can be divided into groups according to the magnitude of individual indicators of demographic

potential or its integral indicator. The main method of applying the geospatial approach is socio-demographic mapping, which helps visualize the territorial differentiation of demographic potential and its individual components.

However, most often researchers do not limit themselves to one method, but use combinations of them, for example: point-rating and grouping (Kornienko, 2014), point-rating and cartographic (Bessmertnyi et al., 2021), index and grouping (Trifonova et al., 2010; Gwiazdzińska-Goraj et al., 2020), point-rating, index, and grouping (Smirennikova et al., 2021), which allows for a more comprehensive and systematic analysis of the state and dynamics of the demographic potential of territories.

**Research methodology**

The study proposes to use a combination of two methods to assess the demographic potential of territories – the index method and the grouping method. If the first one allows generalizing the demographic potential (quantitative and qualitative) of particular territories (regions), then the second one is to divide the totality of these objects into groups according to its size.

The index methodology was based on an idea of the structure of the demographic potential of territories (see Fig.). We proposed a system of two indices – quantitative (QuanDPI) and qualitative (QualDPI) demographic potential. The process of constructing integral indices was based on the methodological recommendations of S.A. Aivazyan and co-authors in the field of constructing synthetic categories of quality of life (Aivazyan et al., 2006) and included the following stages.

1. Creating a set of indicators for calculating indices:

– determination of the initial (a priori) set of indicators at the theoretical level;

– selection from the a priori set using mathematical and statistical methods of a relatively small number of particular criteria that play a crucial role in the formation of the corresponding integral indicator(s), the so-called a posteriori set.

2. Calculation of integral indices of quantitative and qualitative demographic potential:

– unification (normalization) of scales in which partial and integral indicators are measured;

– choosing a method for convolution of particular criteria and determination of weighting coefficients;

– calculation of integral indices.

In our opinion, it is unnecessary to combine the indices of quantitative and qualitative demographic potential into one integral indicator. In this case, it is more informative to rank the territories by their size, to group them according to the size of each index to compare them further.

The a priori set of indicators was determined based on the prevailing ideas in demographic science about the components of demographic dynamics and generalization of the experience of empirical studies of demographic potential *(Tab. 3)*. The set was formed in accordance with the requirements of representativeness, information accessibility and reliability (Aivazyan et al., 2006). The selected indicators, in our opinion, most fully and reliably reflect the analyzed components of demographic potential. To assess the quantitative demographic potential, the main indicators of population size, its location and dynamics (number of permanent population and its rate of change, population density, birth rate, mortality, natural and total growth), population reproduction (depopulation coefficient, net reproduction coefficient, total

**Table 3. A priori set of indicators characterizing the quantitative and qualitative demographic potential of territories**

| Component | Indicator |
|---|---|
| **Quantitative DP** | |
| Population potential and its dynamics | 1. Permanent population (people)<br>2. Population density (people per 1 km$^2$)<br>3. Total population growth (people)<br>4. Fertility rate (per million)<br>5. Mortality rate (ppm)<br>6. Natural growth/loss ratio (ppm)<br>7. Population change rate (%) |
| Population reproduction potential | 1. Depopulation coefficient (ratio of deceased to those born)<br>2. Net reproduction rate (number of girls born to an average of 1 woman throughout their lives and who lived to the age of their mother while maintaining constant fertility and mortality rates)<br>3. Total fertility rate (number of children born to 1 woman of reproductive age) |
| Migration potential | 1. Migration balance ratio (migration balance per 1,000 people)<br>2. The coefficient of migration intensity upon arrival (arrivals per 1,000 people)<br>3. Migration intensity coefficient by departure (departures per 1,000 people)<br>4. Migration efficiency coefficient (ratio of migration gain/loss to gross migration, %) |
| **Qualitative DP** | |
| Gender and age structure potential | 1. Aging index (ratio of the population of 65+ to the population of 0–14 years)<br>2. Demographic load factor of the population under the working age per working-age population (number of persons under the working age per 1,000 people of working age)<br>3. Coefficient of demographic burden over the working age per working-age population (number of people over the working age per 1,000 people of working age)<br>4. Ratio of men to women (number of women per 1000 men)<br>5. Ratio of men and women in reproductive age (number of women per 1000 men aged 15–49)<br>6. Share of women of reproductive age 15–49 years (%) |
| Population health potential | Life expectancy (LE) (years)<br>Healthy life expectancy (HLE) (years)<br>Years of life in a state of ill-being (years)<br>Mortality rate from CD (per 100 thousand people)<br>Mortality rate of the population from NCD (HO) (per 100 thousand people)<br>Mortality rate of the population from EC (per 100 thousand people) |
| Source: own compilation. | |

fertility rate), migration (migration balance coefficients, intensity of migration arrival and departure, migration efficiency), whereas to assess the qualitative potential – key indicators of the gender and age structure (aging index, demographic load coefficients for the population younger and older than working age, ratio of the male and female population, including reproductive age, share of women of reproductive age) and public health (life expectancy, including healthy, years of life in a state of ill health, mortality rates from diseases of the health system blood circulation, neoplasms and external causes). When assessing the qualitative demographic potential, it is important to take into account the structure of mortality due to causes of death. The choice of mortality rates from the listed classes of causes is due to the fact that, first, these are the most common classes of causes in the structure of mortality, and second, they represent larger groups of

nosologies – non-communicable (chronic) diseases and injuries.

The selection of indicators for the a posteriori (reduced) set was based on two requirements: they should directly characterize the integral property; the values of all other (excluded) particular criteria should be accurately restored according to the values of this set of indicators (Aivazyan et al., 2006). First of all, the analysis of the multicollinearity of particular criteria of an a priori set of indicators was carried out. For this purpose, a matrix of values of paired correlation coefficients was calculated, linear regressions were constructed, and the coefficients of determination ($R^2$) of each of the partial criteria of the a priori set were analyzed for all other indicators. The need to reduce variables is evidenced by the presence of strong correlations between their pairs, triples, etc., as well as high values of the coefficients of determination (close to 1) (Aivazyan, 2012). Subsequently, the most informative partial criteria were selected among the indicators of the a priori set, i.e., a set of criteria was selected that corresponds to the maximum value of $R^2$ between the dependent variable in explanatory variables (Aivazyan, 2012). As a result of the manipulations performed, a posteriori set of indicators of the quantitative and qualitative demographic potential of the territories was formed *(Tab. 4)*.

**Table 4. A posteriori set of indicators characterizing the quantitative and qualitative demographic potential of territories**

| Component | Indicator | Variable | Nature of indicator |
|---|---|---|---|
| **Quantitative DP index (QuanDPI)** | | | |
| Population potential and its dynamics | Permanent population | x1 | Direct |
| | Population density | x2 | Direct |
| | Total population growth | x3 | Direct |
| Reproduction potential | Depopulation coefficient (ratio of deceased to those born) | x4 | Inverse |
| Migration potential | Migration efficiency coefficient | x5 | Direct |
| **Qualitative DP index (QualDPI)** | | | |
| Gender and age structure potential | Demographic burden coefficient under the working age per working-age population | X1 | Direct |
| | Ratio of men and women of reproductive age | X2 | Direct* |
| | Share of women of reproductive age 15–49 years old | X3 | Direct |
| Population health potential | HLE | X4 | Direct |
| | Mortality rate from neoplasms | X5 | Inverse |
| | Mortality rate from external causes of death | X6 | Inverse |

* It was assumed to be direct (rather than non-monotonic), since it demonstrates a strong correlation with reproduction indicators, in particular with the net reproduction coefficient (r = 0.92).
Source: own compilation.

The unification of the scales of measurement of partial and integral indicators was carried out by the method of linear scaling (minimax), which involves transformation to a dimensionless form (from 0 to 1), depending on the nature of their relationship with the integral index: in the case of a monotonously increasing dependence (the higher the value of x, the greater the demographic potential) – according to the formula of the direct indicator (1), in the case of monotonically decreasing dependence (the higher the value of x, the lower the demographic potential) – according to the formula of the inverse indicator (2).

$$\widetilde{x} = \frac{x - x_{min}}{x_{max} - x_{min}}, \quad (1)$$

$$\widetilde{x} = 1 - \frac{x - x_{min}}{x_{max} - x_{min}}, \quad (2)$$

where:

$\widetilde{x}$ – unified value of a private index;

$x$– estimated indicator;

$x_{max}$ and $x_{min}$ – maximum and minimum values of the indicator.

The principal component method was chosen as the method of convolution of private variables into an integral index. Each integral indicator was constructed in the form of a modified main component using the covariance matrix $\sum_{\tilde{x}}^{\wedge}(j)$ (Aivazyan, 2012). For all variables included in the groups of private criteria of the QuanDPI and QualDPI, estimates of the covariance matrix were determined and its eigenvalues were found: $((\lambda_1(j) \geq \lambda_2(j) \geq \cdots \lambda_{pj}(j)))$. The equation was solved (Aivazyan, 2012):

$$\left|\sum_{\tilde{x}}^{\wedge}(j) - \lambda_1 I_{pj}\right| = 0, \quad (3)$$

where $I_{pj}$ – unit matrix of dimension $p_j$.

Next, the eigenvector of the largest eigenvalue of the covariance matrix was calculated ($C_1(j) = c_{11}, c_{12}, \dots, c_{pj}$); a system of equations was solved (Aivazyan, 2012):

$$\left(\sum_{\tilde{x}}(j) - \lambda_1 I_{pj}\right) C_1(j) = 0, \quad (4)$$

where the vector $C_1(j) = (c_{11}, c_{12}, \dots, c_{pj})$ has unit length $\sum_{q=1}^{p_j} c_{1q}^2 = 1$.

Then the first main component of the partial criteria was constructed and the integral index (QuanDPI and QualDPI) was constructed according to the formula (Aivazyan, 2012):

$$\hat{y}_i(j) = \sum_{s=1}^{pj} \tilde{c}_{1s}(j) \times \tilde{x}_i^{(s)}(j), \quad (5)$$

where $\tilde{c}_{1s} = c_{1s} / \sum_{m=1}^{pj} c_{1m}$ (the case when all components have the same sign).

At the same time, the share of the explained variance of the first main component, which is based on particular indicators, should be more than 55% (Aivazyan, 2012). The QuanDPI and QualDPI indices take values from 0 (the most unfavorable parameters of demographic potential) to 1 (the most favorable parameters of demographic potential).

All calculations were performed using the R language in the R-Studio program. The observation period was 5 years (2019–2023). Statistical data from Rosstat were used for calculations, in particular, data from the statistical bulletins "Population size and Migration of the Russian Federation"[3], "Natural Movement of the Population of the Russian Federation"[4], and the Unified Interdepartmental Information and Statistical System[5].

[3] Population and migration of the Russian Federation. Rosstat. Available at: https://rosstat.gov.ru/folder/11110/document/13283

[4] Natural movement of the population of the Russian Federation. Rosstat. Available at: https://rosstat.gov.ru/folder/11110/document/13269

[5] Unified interdepartmental information and statistical system. Available at: https://www.fedstat.ru

**Table 5. Weights of the private variables QuanDPI and QualDPI**

| Unif. variable | 2019 | 2020 | 2021 | 2022 | 2023 |
|---|---|---|---|---|---|
| **QuanDPI** | | | | | |
| $\tilde{x}_1$ | 0.14 | 0.01 | 0.04 | 0.13 | 0.13 |
| $\tilde{x}_2$ | 0.13 | 0.03 | 0.05 | 0.14 | 0.11 |
| $\tilde{x}_3$ | 0.21 | 0.27 | 0.25 | 0.21 | 0.23 |
| $\tilde{x}_4$ | 0.38 | 0.64 | 0.60 | 0.42 | 0.35 |
| $\tilde{x}_5$ | 0.13 | 0.05 | 0.06 | 0.10 | 0.17 |
| **QualDPI** | | | | | |
| $\tilde{X}_1$ | 0.16 | 0.19 | 0.17 | 0.14 | 0.18 |
| $\tilde{X}_2$ | 0.11 | 0.13 | 0.12 | 0.13 | 0.12 |
| $\tilde{X}_3$ | 0.20 | 0.23 | 0.21 | 0.21 | 0.27 |
| $\tilde{X}_4$ | 0.11 | 0.06 | 0.11 | 0.10 | 0.06 |
| $\tilde{X}_5$ | 0.28 | 0.28 | 0.26 | 0.28 | 0.29 |
| $\tilde{X}_6$ | 0.13 | 0.11 | 0.12 | 0.14 | 0.07 |
| Source: own compilation with the use of R language. | | | | | |

*Table 5* presents the calculated weights of the unified variables for each index. This technique assumes the calculation of weighting coefficients for each year of observation, which imposes certain restrictions on the analysis of the dynamics of integral indices, but does not affect the correctness of interregional comparisons within one year. However, despite the change in values during the period under review, the ranks of the main weights are generally stable over time.

After calculating the integral indices of quantitative and qualitative demographic potential for each year of observation, the regions were grouped according to their size[6], and then a matrix of their conjugation was constructed by comparing the groups of regions according to the level of the QuanDPI and QualDPI indices.

**Results**

The calculations performed showed that the top ten leaders in terms of the index of quantitative demographic potential throughout the period under review were the metropolitan regions (Moscow and the Moscow Region, Saint Petersburg), the regions of the North Caucasus (Ingushetia, Chechnya, Dagestan), the Tyumen Region, Khanty-Mansi and Yamal-Nenets autonomous areas, and the republics of Sakha (Yakutia) and Tyva *(Tab. 6)*. In some years, the Nenets Autonomous Area (2020, 2022, 2023), Sevastopol (2020) and the Krasnodar Territory (2023) were in the group of leaders.

The subjects of the Central Federal District (Vladimir, Tambov, Tver, Smolensk regions) and the Penza Region were among the outsider regions every year. The Pskov, Tula, Orel, Saratov and Ivanovo regions also belonged

6 The entire set of RF constituent entities was divided into three groups: regions with low, average and high levels of indicators. The group of regions with an average level of indicators included subjects whose values were in the "arithmetic mean ± standard deviation" range, and subjects whose values were below or above this range were included in the groups of regions with low and high levels, respectively.

to this category during most of the years of observation. In some years, the group of anti-leaders included the Novgorod (2019 and 2021), Ryazan (2021 and 2022), Kurgan (2023) regions and the Republic of Mordovia (2020 and 2022).

In the Vologda Region, the QualDPI increased over the period 2019–2023, as a result, the region rose from 58th to 53rd place in the ranking of Russian regions in terms of its size.

**Table 6. Regions – leaders and outsiders in the QuanDPI in 2019–2023**

| 2019 | | 2020 | | 2021 | | 2022 | | 2023 | |
|---|---|---|---|---|---|---|---|---|---|
| Region | QuanDPI | Region | QuanDPI | Region | QuanDPI | Region | QuanDPI | Region | QuanDPI |
| **Leading regions (top ten)** | | | | | | | | | |
| Moscow | 0.749 | Chechen Republic | 0.778 | Republic of Ingushetia | 0.760 | Moscow | 0.849 | Moscow | 0.801 |
| Moscow Region | 0.574 | Republic of Ingushetia | 0.776 | Chechen Republic | 0.751 | Republic of Ingushetia | 0.567 | Moscow Region | 0.675 |
| Republic of Ingushetia | 0.559 | Republic of Dagestan | 0.755 | Republic of Dagestan | 0.732 | Republic of Dagestan | 0.562 | KhMAA | 0.627 |
| Chechen Republic | 0.507 | Republic of Tyva | 0.686 | YaNAA | 0.681 | Chechen Republic | 0.535 | Republic of Ingushetia | 0.609 |
| Saint Petersburg | 0.504 | YaNAA | 0.684 | Republic of Tyva | 0.672 | Moscow Region | 0.527 | Republic of Dagestan | 0.545 |
| Republic of Dagestan | 0.502 | KhMAA | 0.673 | KhMAA | 0.664 | KhMAA | 0.519 | Saint Petersburg | 0.498 |
| KhMAA | 0.447 | Republic of Sakha (Yakutia) | 0.645 | Republic of Sakha (Yakutia) | 0.623 | Saint Petersburg | 0.494 | Nenets AA | 0.493 |
| Tyumen Region | 0.435 | Sevastopol | 0.622 | Moscow Region | 0.606 | YaNAA | 0.485 | Krasnodar Territory | 0.490 |
| YaNAA | 0.434 | Nenets AA | 0.599 | Kabardino-Balkarian Republic | 0.585 | Republic of Tyva | 0.466 | Chechen Republic | 0.489 |
| Krasnodar Territory | 0.428 | Kabardino-Balkarian Republic | 0.574 | Nenets AA | 0.566 | Republic of Sakha (Yakutia) | 0.444 | YaNAA | 0.481 |
| **Outsider regions (the last ten)** | | | | | | | | | |
| Vladimir Region | 0.134 | Ivanovo Region | 0.116 | Novgorod Region | 0.146 | Penza Region | 0.140 | Kurgan Region | 0.184 |
| Novgorod Region | 0.129 | Pskov Region | 0.114 | Penza Region | 0.142 | Ryazan Region | 0.128 | Penza Region | 0.180 |
| Penza Region | 0.116 | Tver Region | 0.109 | Orel Region | 0.139 | Republic of Mordovia | 0.126 | Ivanovo Region | 0.178 |
| Tver Region | 0.115 | Saratov Region | 0.107 | Tver Region | 0.134 | Tver Region | 0.122 | Saratov Region | 0.177 |
| Orel Region | 0.115 | Republic of Mordovia | 0.099 | Tambov Region | 0.124 | Orel Region | 0.116 | Tver Region | 0.163 |
| Pskov Region | 0.113 | Penza Region | 0.093 | Saratov Region | 0.116 | Tambov Region | 0.114 | Pskov Region | 0.148 |
| Ivanovo Region | 0.107 | Tambov Region | 0.088 | Ryazan Region | 0.097 | Pskov Region | 0.112 | Tambov Region | 0.147 |
| Smolensk Region | 0.096 | Smolensk Region | 0.074 | Vladimir Region | 0.097 | Tula Region | 0.108 | Orel Region | 0.135 |
| Tambov Region | 0.096 | Vladimir Region | 0.063 | Tula Region | 0.090 | Vladimir Region | 0.101 | Smolensk Region | 0.120 |
| Tula Region | 0.077 | Tula Region | 0.035 | Smolensk Region | 0.088 | Smolensk Region | 0.070 | Vladimir Region | 0.109 |
| **Vologda Region** | | | | | | | | | |
| *58th place* | *0.197* | *47th place* | *0.301* | *52nd place* | *0.306* | *54th place* | *0.242* | *53rd place* | *0.251* |

Source: own compilation.

The top 10 regions of Russia with the highest index of qualitative demographic potential during 2019–2023 included the republics of the North Caucasus (Chechnya, Ingushetia, Dagestan, Karachay-Cherkessia and Kabardino-Balkaria), the Republics of Sakha and Tuva, the Yamal-Nenets and Khanty-Mansi Autonomous areas *(Tab. 7)*, most of which were also leaders in terms of the size of the QuanDPI. In 2023, the Tyumen Region was ranked among the top ten leaders in terms of the QualDPI.

The Pskov, Kurgan, Vladimir and Tula regions were consistently included in the number of outsider regions during the observation period. The Tver, Smolensk, Bryansk, Arkhangelsk, Kirov, and Ulyanovsk regions were also often among the representatives of this category of regions. At the same time, some of the listed constituent entities of the Russian Federation were in a similar group according to the QuanDPI index (Vladimir, Pskov, Smolensk, Tula, and Tver regions). In some years, the top

**Table 7. Regions – leaders and outsiders in terms of QualDP in 2019–2023**

| 2019 | | 2020 | | 2021 | | 2022 | | 2023 | |
|---|---|---|---|---|---|---|---|---|---|
| Region | QualDPI | Region | QualDPI | Region | QualDPI | Region | QualDPI | Region | QualDPI |
| **Leading regions (top ten)** | | | | | | | | | |
| Republic of Ingushetia | 0.915 | Republic of Ingushetia | 0.903 | Republic of Ingushetia | 0.920 | Republic of Ingushetia | 0.930 | Republic of Ingushetia | 0.851 |
| Chechen Republic | 0.818 | Chechen Republic | 0.769 | Chechen Republic | 0.776 | Chechen Republic | 0.771 | Chechen Republic | 0.764 |
| Republic of Dagestan | 0.737 | Republic of Dagestan | 0.728 | Republic of Dagestan | 0.756 | Republic of Dagestan | 0.767 | Republic of Tyva | 0.749 |
| YaNAA | 0.580 | Republic of Tyva | 0.620 | Republic of Tyva | 0.626 | YaNAA | 0.628 | Republic of Dagestan | 0.744 |
| Republic of Tyva | 0.578 | YaNAA | 0.608 | YaNAA | 0.615 | Karachayevo-Circassian Republic | 0.603 | YaNAA | 0.688 |
| KhMAA | 0.555 | Karachayevo-Circassian Republic | 0.586 | Karachayevo-Circassian Republic | 0.595 | Kabardino-Balkarian Republic | 0.597 | Karachayevo-Circassian Republic | 0.639 |
| Kabardino-Balkarian Republic | 0.537 | KhMAA | 0.568 | Kabardino-Balkarian Republic | 0.574 | KhMAA | 0.596 | Kabardino-Balkarian Republic | 0.626 |
| Republic of Sakha (Yakutia) | 0.535 | Republic of Sakha (Yakutia) | 0.564 | KhMAA | 0.569 | Republic of Tyva | 0.570 | KhMAA | 0.619 |
| Karachayevo-Circassian Republic | 0.532 | Kabardino-Balkarian Republic | 0.557 | Republic of North Ossetia – Alania | 0.529 | Republic of Sakha (Yakutia) | 0.538 | Republic of Sakha (Yakutia) | 0.592 |
| Republic of North Ossetia – Alania | 0.504 | Republic of North Ossetia – Alania | 0.507 | Republic of Sakha (Yakutia) | 0.526 | Republic of North Ossetia – Alania | 0.522 | Tyumen Region | 0.577 |
| **Outsider regions (the last ten)** | | | | | | | | | |
| Jewish Autonomous Region | 0.233 | Sakhalin Region | 0.253 | Ulyanovsk Region | 0.274 | Ulyanovsk Region | 0.263 | Kostroma Region | 0.271 |
| Bryansk Region | 0.233 | Arkhangelsk Region | 0.248 | Kursk Region | 0.273 | Smolensk Region | 0.260 | Vladimir Region | 0.263 |
| Sevastopol | 0.233 | Smolensk Region | 0.248 | Arkhangelsk Region | 0.272 | Tver Region | 0.259 | Ulyanovsk Region | 0.259 |
| Smolensk Region | 0.227 | Vladimir Region | 0.246 | Vladimir Region | 0.271 | Tula Region | 0.257 | Arkhangelsk Region | 0.253 |
| Sakhalin Region | 0.224 | Kirov Region | 0.246 | Smolensk Region | 0.264 | Amur Region | 0.257 | Tver Region | 0.250 |
| Vladimir Region | 0.220 | Bryansk Region | 0.242 | Tver Region | 0.259 | Arkhangelsk Region | 0.256 | Kirov Region | 0.246 |
| Tula Region | 0.216 | Tver Region | 0.235 | Kurgan Region | 0.253 | Vladimir Region | 0.256 | Tula Region | 0.245 |
| Tver Region | 0.209 | Kurgan Region | 0.226 | Bryansk Region | 0.250 | Kirov Region | 0.252 | Kaluga Region | 0.243 |
| Kurgan Region | 0.195 | Tula Region | 0.192 | Tula Region | 0.222 | Kurgan Region | 0.203 | Kurgan Region | 0.219 |
| Pskov Region | 0.145 | Pskov Region | 0.152 | Pskov Region | 0.185 | Pskov Region | 0.164 | Pskov Region | 0.207 |
| **Vologda Region** | | | | | | | | | |
| *58th place* | *0.292* | *56th place* | *0.320* | *38th place* | *0.361* | *43rd place* | *0.365* | *57th place* | *0.358* |
| Source: own compilation. | | | | | | | | | |

ten anti-leaders were the Jewish Autonomous Region (2019) and Sevastopol (2019), the Sakhalin (2019–2020), Amur (2022), and Kostroma (2023) regions.

The Vologda Region's position in terms of the QualDPI fluctuated noticeably: if in 2019 the region ranked 56th place, by 2021, it had improved its position, rising to 38th place, but since 2022 the region began declining again, moving to 57th place by 2023. Nevertheless, the index of qualitative demographic potential in the region increased from 0.292 to 0.358.

To compare the position of the regions according to the QuanDPI and QualDPI indices, the regions were grouped according to the size of each of them, and then the index conjugation matrices were constructed. As a result, 7 variants were identified out of nine groups (possible combinations of the ratio of the QuanDPI and QualDPI) *(Tables 8, 9)*. The group of regions with an average level of indices of quantitative and qualitative demographic potential turned out to be the most numerous (59 regions each in 2019 and 2023). In 2019 and 2023, 7 and 6 regions, respectively, were included in the number of subjects with high QuanDPI and QualDPI values, mainly the Chechen Republic, the republics of Ingushetia, Dagestan, Sakha (Yakutia), the Khanty-Mansi and Yamal-Nenets Autonomous areas. There were 3 regions in the group of subjects with low levels of both indices in both 2019 and 2023 (Tver and Pskov regions, Tula Region in 2019 and Vladimir Region in 2023).

Other Russian regions have demonstrated some mismatch in the levels of demographic potential indices: high QuanDPI and average

**Table 8. Matrix of Russian regions by the ratio of QuanDPI and QualDPI, 2019**

| | | Quantitative DP index (QuanDPI) | | |
|---|---|---|---|---|
| | | High (above 0.391) | Average (from 0.143 to 0.391) | Low (below 0.143) |
| Qualittative DP index (QualDPI) | High (above 0.477) | (7)<br>Republic of Ingushetia, Chechen Republic, Republics of Dagestan, Tuva, Sakha (Yakutia), Khanty-Mansi Autonomous Area, Yamal-Nenets Autonomous Area | (3)<br>Kabardino-Balkarian, Karachayevo-Circassian republics, Republic of North Ossetia – Alania | – |
| | Average (from 0.220 to 0.477) | (5)<br>Moscow, Saint Petersburg, Moscow, Tyumen regions, Krasnodar Territory | (59)<br>Republics of Altai, Tatarstan, Buryatia, Adygea, Kalmykia, Bashkortostan, Crimea, Mari El, Khakassia, Udmurtia; Chuvash, Komi republics, republics of Karelia, Mordovia; Nenets Autonomous Area, Chukotka Autonomous Area, Altai, Krasnoyarsk, Kamchatka, Trans-Baikal, Stavropol, Perm, Primorye, Khabarovsk territories; Novosibirsk, Kaliningrad, Tomsk, Sverdlovsk, Leningrad, Sakhalin, Irkutsk, Samara, Rostov, Chelyabinsk, Orenburg, Astrakhan, Belgorod, Magadan, Amur, Murmansk, Voronezh, Nizhny Novgorod, Omsk, Vologda, Arkhangelsk, Lipetsk, Yaroslavl, Kemerovo, Kostroma, Volgograd, Ulyanovsk, Kaluga, Kursk, Kirov, Ryazan, Saratov, Bryansk regions; Jewish Autonomous Region, Sevastopol | (7)<br>Vladimir, Novgorod, Penza, Orel, Ivanovo, Smolensk, Tambov regions |
| | Low (below 0.220) | – | (1)<br>Kurgan Region | (3)<br>Tver, Pskov, Tula regions |

Source: own compilation.

QualDPI (5 regions in 2019 and 6 regions in 2023), average QuanDPI and high QualDPI (3 regions each in 2019 and 2023), low QuanDPI and average QualDPI (7 regions in 2019 and 6 regions in 2023), average QuanDPI and low QualDPI (1 region in 2019 and 2 regions in 2023). Nevertheless, regions with polar index levels (high QuanDPI and low QualDPI and vice versa) have not been identified, which may indicate a pronounced mutual conditionality of quantitative and qualitative demographic potential. Indeed, correlation analysis shows that there is a strong direct relationship between the QuanDPI and the QualDPI: the correlation coefficients were: in 2019 – 0.72, in 2020 and 2021 – 0.8, in 2022 – 0.74, in 2023 – 0.70.

## Conclusion

Thus, despite the variety of approaches to determining the essence of demographic potential, highlighting its components and indicators for analysis, it is possible to identify their similar features:

– demographic potential is most often considered as the available demographic resource of a territory;

– quantitative and qualitative characteristics should be distinguished when studying it; the main indicators for analyzing demographic potential are indicators of population size and its dynamics, reproduction, migration, gender and age structure, and some other qualitative indicators, such as population health.

**Table 9. Matrix of Russian regions by the ratio of QuanDPI and QualDPI, 2023**

| | | Quantitative DP index (QuanDPI) | | |
|---|---|---|---|---|
| | | High (above 0.442) | Average (from 0.183 to 0.442) | Low (below 0.183) |
| Qualittative DP index (QualDPI) | High (above 0.541) | (6)<br>Republics of Ingushetia, Dagestan, Chechen Republic, Republic of Sakha (Yakutia), Yamal-Nenets Autonomous Area, Khanty-Mansi AA | (3)<br>Kabardino-Balkarian Republic, Republics of Tyva, Karachayevo-Circassian Republic | – |
| | Average (from 0.282 to 0.541) | (6)<br>Moscow, Saint Petersburg, Nenets Autonomous Area, Krasnodar Territory, Moscow, Tyumen regions | (59)<br>Republics of Kalmykia, Tatarstan, Adygea, Altai, Buryatia, Bashkortostan, North Ossetia – Alania, Khakassia, Mari El, Crimea, Udmurtia, Komi, Chuvash republics, republics of Karelia, Mordovia, Chukotka Autonomous Area, Khabarovsk, Perm, Kamchatka, Stavropol, Krasnoyarsk, Primorye, Trans-Baikal, Altai territories, Leningrad, Novosibirsk, Kaliningrad, Chelyabinsk, Astrakhan, Rostov, Sverdlovsk, Murmansk, Sakhalin, Kaluga, Magadan, Irkutsk, Samara, Amur, Orenburg, Vologda, Tomsk, Voronezh, Yaroslavl, Kursk, Omsk, Ulyanovsk, Volgograd, Kirov, Arkhangelsk, Nizhny Novgorod, Kostroma, Kemerovo, Novgorod, Lipetsk, Bryansk, Belgorod, Ryazan regions, Jewish autonomous Region, Sevastopol | (6)<br>Penza, Ivanovo, Saratov, Tambov, Orel, Smolensk regions |
| | Low (below 0.282) | – | (2)<br>Tula, Kurgan regions | (3)<br>Tver, Pskov, Vladimir regions |

Source: own compilation.

Several methodological approaches have been formed to measure the demographic potential of territories – basic (statistical-descriptive, criterion-statistical) and auxiliary (typological and geospatial). Each of them uses its own methods, but several methods can be used to comprehensively assess its condition and dynamics.

Our study proposes to use a combination of two methods – the index method and the grouping method. The developed methodology for calculating integral indices of quantitative and qualitative demographic potential has several advantages: it takes into account the structure of demographic potential; it is based on available statistical information; calculation procedures are carried out using proven econometric methods that eliminate problems of multicollinearity and duplication of data; it is convenient to use and interpret the results. Its combination with the grouping method makes it possible not only to assess the differences between territories in terms of the size of the indices, but also to compare them in terms of the level and ratio of the indices.

The testing of the index methodology in the RF constituent entities allowed drawing a number of conclusions. During 2019–2023, the filling of the groups of leaders and outsiders in terms of the size of the QuanDPI and QualDPI was relatively stable. Among the leaders in the index of quantitative demographic potential, Moscow and Saint Petersburg, the Moscow Region, the Chechen Republic, the Republics of Dagestan and Ingushetia, Sakha and Tuva, the Tyumen Region, the Khanty-Mansi and Yamal-Nenets Autonomous areas, while the Vladimir, Tambov, Tver, Smolensk, Penza, Pskov, Tula, Orel, Saratov and Ivanovo regions are among the outsiders. It is noteworthy that the composition of the ten regions with the maximum and minimum values of the index of qualitative demographic potential largely repeats that of the QuanDPI: the top leaders traditionally include the Chechen Republic, the republics of Ingushetia, Dagestan, Sakha and Tuva, the Karachayevo-Circassian and Kabardino-Balkarian republics, the Yamal-Nenets and Khanty-Mansi autonomous areas, while the outsiders – the Pskov, Kurgan, Vladimir, Tula, Tver, Smolensk, Bryansk, Arkhangelsk, Kirov and Ulyanovsk regions. A comparison of the groups of regions by the value of the QuanDPI and QualDPI allowed concluding that the indices are clearly consistent with each other: the majority of constituent entities of the Russian Federation (59 regions in 2019 and 2023, respectively) have average values, while some regions are characterized by high values (7 and 6 regions in 2019 and 2023, respectively) and, conversely, low (3 regions in 2019 and 2023, respectively) values. In other regions, there is some misalignment of the indices, however, no combination of opposite levels of the QuanDPI and QualDPI (high and low) was found in any constituent entity of the Russian Federation. Their consistency is also evidenced by the high correlation coefficients between the indices, which may indicate a close relationship between the quantitative and qualitative components of demographic potential, both due to their interdependence (the number of people determines its quality or, conversely, quality determines quantity) and the commonality of their determinants (time factor, level of socio-economic development of the region, quality of life, demographic policy, etc.).

The conducted research contributes to the development of the methodology for assessing demographic potential at the regional level in Russia. The developed methodology serves as a tool for identifying problems of preserving demographic potential, and the results of its testing serve as a scientifically sound basis for policy in the field of territorial development management. The index methodology can form the basis for monitoring the demographic situation in Russian regions and assessing the effectiveness of demographic policy in them.

## REFERENCES


Aivazyan S.A. (2012). *Analiz kachestva i obraza zhizni naseleniya* [Analysis of the Quality and Lifestyle of the Population]. Moscow: Nauka.

Aivazyan S.A., Stepanov V.S., Kozlova M.I. (2006). Measuring synthetic categories of the quality of life of the region's population and identifying key areas for improving socio-economic policy. *Prikladnaya ekonometrika*, 2, 18–84 (in Russian).

Arkhangelskiy V.N., Kozlova O.A., Kalachikova O.N. (2023). Regional differences in fertility rates in real generations in Russia (according to the 2020 population census). *Problemy sotsial'noi gigieny, zdravookhraneniya i istorii meditsiny*, 31(2), 1165–1170. DOI: http://dx.doi.org/10.32687/0869-866X-2023-31-s2-1165-1170 (in Russian).

Bessmertnyi I.V., Latun V.V., Merinova Yu.Yu., Khovanskii A.D. (2021). Demographic potential and spatial development of the Rostov region. *Uspekhi sovremennogo estestvoznaniya=Advances in Current Natural Sciences*, 3, 26–34. DOI: https://doi.org/10.17513/use.37590 (in Russian).

Dobrokhleb V.G., Sigareva E.P. (2019). The demographic capacity of the Vologda Oblast. *Problemy razvitiya territorii=Problems of Territory's Development,* 4(102), 118–131. DOI: 10.15838/ptd.2019.4.102.7 (in Russian).

Fauzer V.V. (2014). Demographic potential of the Russia's northern regions as a factor and condition of economic development of the Arctic. *Ekonomika regiona*, 4(40), 69–81 (in Russian).

Frenkel' A.A., Sergienko Ya.V., Volkova N.N., Smirnov S.V., Roshchina L.S. (2015). Some approaches to the construction of integral indices of Russia's economic development. *Ekonomika i predprinimatel'stvo*, 11(1), 86–91 (in Russian).

Gabdrakhmanov N.K., Rubtzov V.A., Mustafin M.R., Pratchenko O.V. (2014). Geodemographic potential of the Republic of Tatarstan: Analysis, evaluation, territorial differences. social geography. *Mediterranean Journal of Social Sciences*, 5 (4), 278–284.

Gwiaździńska-Goraj M., Pawlewicz K., Jezierska-Thöle A. (2020). Differences in the quantitative demographic potential – a comparative study of Polish–German and Polish–Lithuanian transborder regions. *Sustainability*, 12(22). DOI: https://doi.org/10.3390/su12229414. DOI: 10.3390/su12229414

Kalugina Z.I., Fadeeva O.P., Bratyushchenko S.V. (2015). Socio-demographic potential of rural development in Russia. *EKO=ECO Journal*, 7, 127–135 (in Russian).

Koišová E., Masárová J., Ivanová E. (2021). Socio-demographic potential of human resources in the Visegrad regions. *Journal of Business Economics and Management*, 22(4), 1026–1046. DOI: https://doi.org/10.3846/jbem.2021.14541

Kornienko O.S. (2014). Comparative assessment of the potentials of the Far East regions. *Regional'nye issledovaniya*, 1, 42–49 (in Russian).

Korolenko A.V. (2020). Mortality of the population of Russian regions in the current decade: Trends, structure and differentiation of indicators. *Sotsial'noe prostranstvo=Social Area,* 6(3). DOI: 10.15838/sa.2020.3.25.7. Available at: http://socialarea-journal.ru/article/28619 (in Russian).

Korolenko A.V. (2021). Demographic potential of Vologda Municipal District: Statistical and sociological aspects. *Voprosy territorial'nogo razvitiya=Territorial Development Issues,* 9(5). DOI: 10.15838/tdi.2021.5.60.5. Available at: http://vtr.isert-ran.ru/article/29120 (in Russian).

Kvasha E.A., Khar'kova T.L. (2022). COVID-19 pandemic and mortality by main causes of death in regions of the Russian Federation in 2020. *Regional'nye issledovaniya*, 4(78), 61–75. DOI: 10.5922/1994-5280-2022-4-6 (in Russian).

Matraeva L.V. (2024). Monitoring of external migration processes as a tool of regional migration policy. *Intellekt. Innovatsii. Investitsii*, 4, 11–25. DOI: 10.25198/2077-7175-2024-4-11 (in Russian).

Mladenov C. (2016). Demographic potential and problems of the settlements network in the mountains of Bulgaria. In: Zhelezov G. (Ed.). *Sustainable Development in Mountain Region*s. Cham: Springer. DOI: 10.1007/978-3-319-20110-8_15

Pastuszka S. (2017). Regional differentiation of the demographic potential in Italy and Poland. *Comparative Economic Research-Central and Eastern Europe*, 20(3), 137–159. DOI: 10.1515/cer-2017–0024

Pavlova I.A., Gumennikov I.V., Monastyrny E.A., Sharma D. (2018). What is behind composite well-being indices? *Vestnik nauki Sibiri*, 4(31), 230–254 (in Russian).

Rodionova L.A., Kopnova E.D. (2020). Gender and regional differences in life expectancy in Russia. *Voprosy statistiki*, 27(1), 106–120. DOI: 10.34023/2313-6383-2020-27-1-106-120 (in Russian).

Rybakovskii L.L. (2008). Comparative assessment of demographic disadvantage of Russian regions. *Sotsiologicheskie issledovaniya*, 10, 81–87 (in Russian).

Rybakovskii O.L. (2023). Demographic potential: Essence, structure and main factors. *Uroven' zhizni naseleniya regionov Rossii=Living Standards of the Population in the Regions of Russia,* 19(3), 319–326. DOI: https://doi.org/10.52180/1999-9836_2023_19_3_1_319_326 (in Russian).

Rybakovskii O.L., Fadeeva T.A. (2022). Structural demographic waves of Russian regions: Preliminary analysis. *Uroven' zhizni naseleniya regionov Rossii=Living Standards of the Population in the Regions of Russia,* 18(4), 425–438. DOI: 10.19181/lsprr.2022.18.4.1 (in Russian).

Rybakovskii O.L., Tayunova O.A. (2019). Demographic potential: From the history of the concept. *Narodonaselenie=Population,* 2, 17–25. DOI: 10.24411/1561-7785-2019-00012 (in Russian).

Rybakovsky L.L. (2024). Reproduction of the population of the regions of Russia in 1992–2024: Results, components, factors. *Narodonaselenie=Population,* 27(4), 4–17. DOI: 10.24412/1561-7785-2024-4-4-17 (in Russian).

Shubat O.M., Bagirova A.P., Akishev A.A. (2019). Methodology for analyzing the demographic potential of Russian regions using fuzzy clusterization. *Ekonomika regiona=Economy of Region*, 15(1), 178–190 (in Russian).

Simagin Yu.A. (2013). The role of demographic potential in the economic development of Russian regions. *Ekonomika. Nalogi. Pravo*, 6, 43–48 (in Russian).

Smirennikova E.V., Ukhanova A.V., Voronina L.V. (2018). Review of modern methodological approaches to assessing demographic potential. *Fundamental'nye issledovaniya=Fundamental Research*, 11(2), 307–313. DOI: https://doi.org/10.17513/fr.42342. Available at: https://fundamental-research.ru/ru/article/view?id=42342 (in Russian).

Smirennikova E.V., Voronina L.V., Ukhanova A.V. (2021). Assessment of the demographic potential of the Arctic regions of the Russian Federation in the context of innovative development. *Arktika: ekologiya i ekonomika*, 11(1), 19–29. DOI: 10.25283/2223-4594-2021-1-19-29 (in Russian).

Smirnov A.V. (2024). Interregional migration flows in Russia: A network approach. *AlterEconomics*, 21(2), 286–301. DOI: 10.31063/AlterEconomics/2024.21-2.7 (in Russian).

Sobczyk A., Archuadze Z. (2016). Assessment of demographic potential of the Tbilisi Metropolitan Area with the use of synthetic variable. *Folia Pomeranae Universitatis Technologiae Stetinensis. Oeconomica*, 85, 147–158. DOI: 10.21005/oe.2016.85.4.15

Sojka E. (2012). Demographic potential of the countries that have applied for the European Union membership. *Bulletin of Geography. Socio-economic Series*, 17, 135–145. DOI: 10.2478/v10089-012-0014-4

Stojanović J., Kokotović-Kanazir Vl., Stojanović M. (2017). Does small town with touristic function have demographic potential? *Journal of the Geographical Institute "Jovan Cvijic"*, 67(2), 145–162. DOI: 10.2298/IJGI1702145S

Sukneva S.A. (2010). *Demograficheskii potentsial razvitiya naseleniya severnogo regiona* [Demographic Development Potential of the Population of the Northern Region]. Novosibirsk: Nauka.

Trifonova Z.A., Danilov I.P., Davydova T.A., Rostovtseva M.M. (2010). The demographic potential of the regions of Russia and the analysis regional politics of demographic (for example regions Privolgsky Federal District). *Vestnik Chuvashskogo universiteta*, 4, 446–451 (in Russian).

Yarnykh E.A., Konstantinova A.G. (2017). The system of statistical indicators for the analysis of the demographic potential of the region. *Rossiya: tendentsii i perspektivy razvitiya*, 12–1, 759–763 (in Russian).

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## ЛИТЕРАТУРА

Айвазян С.А. (2012). Анализ качества и образа жизни населения / Центральный экономико-математический ин-т РАН. Москва: Наука. 432 с.

Айвазян С.А., Степанов В.С., Козлова М.И. (2006). Измерение синтетических категорий качества жизни населения региона и выявление ключевых направлений совершенствования социально-экономической политики // Прикладная эконометрика. № 2. С. 18–84.

Архангельский В.Н., Козлова О.А., Калачикова О.Н. (2023). Региональные различия показателей рождаемости в реальных поколениях в России (по данным переписи населения 2020 года) // Проблемы социальной гигиены, здравоохранения и истории медицины. № 31 (2). С. 1165–1170. DOI: http://dx.doi.org/10.32687/ 0869-866X-2023-31-s2-1165-1170

Бессмертный И.В., Латун В.В., Меринова Ю.Ю., Хованский А.Д. (2021). Демографический потенциал и пространственное развитие Ростовской области // Успехи современного естествознания. № 3. С. 26–34. DOI: https://doi.org/10.17513/use.37590

Доброхлеб В.Г., Сигарева Е.П. (2019). Демографический потенциал Вологодской области // Проблемы развития территории. № 4 (102). С. 118–131. DOI: 10.15838/ptd.2019.4.102.7

Калугина З.И., Фадеева О.П., Братющенко С.В. (2015). Социально-демографический потенциал развития сельских территорий России // ЭКО. № 7. С. 127–135.

Кваша Е.А., Харькова Т.Л. (2022). Пандемия COVID-19 и смертность от основных причин смерти в регионах Российской Федерации в 2020 г. // Региональные исследования. № 4 (78). С. 61–75. DOI: 10.5922/1994-5280-2022-4-6

Корниенко О.С. (2014). Сравнительная оценка потенциалов регионов Дальнего Востока // Региональные исследования. № 1. С. 42–49.

Короленко А.В. (2021). Демографический потенциал Вологодского муниципального района: статистический и социологический аспекты // Вопросы территориального развития. Т. 9. № 5. DOI: 10.15838/tdi.2021.5.60.5. URL: http://vtr.isert-ran.ru/article/29120

Короленко А.В. (2020). Смертность населения регионов России в текущем десятилетии: тенденции, структура и дифференциация показателей // Социальное пространство. Т. 6. № 3. DOI: 10.15838/sa.2020.3.25.7. URL: http://socialarea-journal.ru/article/28619

Матраева Л.В. (2024). Мониторинг процессов внешней миграции как инструмент региональной миграционной политики // Интеллект. Инновации. Инвестиции. № 4. С. 11–25. DOI: 10.25198/2077-7175-2024-4-11

Павлова И.А., Гуменников И.В., Монастырный Е.А., Шарма Д. (2018). Что стоит за интегральными индексами благополучия? // Вестник науки Сибири. № 4 (31). С. 230–254.

Родионова Л.А., Копнова Е.Д. (2020). Гендерные и региональные различия в ожидаемой продолжительности жизни в России // Вопросы статистики. Т. 27. № 1. С. 106–120. DOI: 10.34023/2313-6383-2020-27-1-106-120

Рыбаковский Л.Л. (2008). Сравнительная оценка демографического неблагополучия регионов России // Социологические исследования. № 10. С. 81–87.

Рыбаковский О.Л. (2024). Воспроизводство населения регионов России в 1992–2024 гг.: итоги, компоненты, факторы // Народонаселение. Т. 27. № 4. С. 4–17. DOI: 10.24412/1561-7785-2024-4-4-17

Рыбаковский О.Л. (2023). Демографический потенциал: сущность, структура и основные факторы // Уровень жизни населения регионов России. Т. 19. № 3. С. 319–326. DOI: https://doi.org/10.52180/1999-9836_2023_19_3_1_319_326

Рыбаковский О.Л., Таюнова О.А. (2019). Демографический потенциал: из истории понятия // Народонаселение. № 2. С. 17–25. DOI: 10.24411/1561-7785-2019-00012

Рыбаковский О.Л., Фадеева Т.А. (2022). Структурные демографические волны регионов России: предварительный анализ // Уровень жизни населения регионов России. Т. 18. № 4. С. 425–438. DOI: 10.19181/lsprr.2022.18.4.1

Симагин Ю.А. (2013). Роль демографического потенциала в экономическом развитии регионов России // Экономика. Налоги. Право. № 6. С. 43–48.

Смиренникова Е.В., Воронина Л.В., Уханова А.В. (2021). Оценка демографического потенциала арктических регионов Российской Федерации в контексте инновационного развития // Арктика: экология и экономика. Т. 11. № 1. С. 19–29. DOI: 10.25283/2223-4594-2021-1-19-29

Смиренникова Е.В., Уханова А.В., Воронина Л.В. (2018). Обзор современных методических подходов к оценке демографического потенциала // Фундаментальные исследования. № 11. Ч. 2. С. 307–313. DOI: https://doi.org/10.17513/fr.42342. URL: https://fundamental-research.ru/ru/article/view?id=42342

Смирнов А.В. (2024). Межрегиональные миграционные потоки в России: сетевой подход // AlterEconomics. Т. 21. № 2. С. 286–301. DOI: 10.31063/AlterEconomics/2024.21-2.7

Сукнева С.А. (2010). Демографический потенциал развития населения северного региона. Новосибирск: Наука. 168 с.

Трифонова З.А., Данилов И.П., Давыдова Т.А., Ростовцева М.М. (2010). Демографический потенциал регионов России и анализ региональной демографической политики (на примере Приволжского федерального округа) // Вестник Чувашского университета. № 4. С. 446–451.

Фаузер В.В. (2014). Демографический потенциал северных регионов России – фактор и условие экономического освоения Арктики // Экономика региона. № 4 (40). С. 69–81.

Френкель А.А., Сергиенко Я.В., Волкова Н.Н., Смирнов С.В., Рощина Л.С. (2015). Некоторые подходы к построению интегральных индексов экономического развития России // Экономика и предпринимательство. № 11. Ч. 1. С. 86–91.

Шубат О.М., Багирова А.П., Акишев А.А. (2019). Методика анализа демографического потенциала российских регионов на основе нечеткой кластеризации данных // Экономика региона. Т. 15. № 1. С. 178–190.

Ярных Э.А., Константинова А.Г. (2017). Система статистических показателей анализа демографического потенциала региона // Россия: тенденции и перспективы развития. № 12–1. С. 759–763.

Gabdrakhmanov N.K., Rubtzov V.A., Mustafin M.R., Pratchenko O.V. (2014). Geodemographic potential of the Republic of Tatarstan: Analysis, evaluation, territorial differences. social geography. *Mediterranean Journal of Social Sciences*, 5 (4), 278–284.

Gwiaździńska-Goraj M., Pawlewicz K., Jezierska-Thöle A. (2020). Differences in the quantitative demographic potential – a comparative study of Polish–German and Polish–Lithuanian transborder regions. *Sustainability*, 12(22). DOI: https://doi.org/10.3390/su12229414. DOI: 10.3390/su12229414

Koišová E., Masárová J., Ivanová E. (2021). Socio-demographic potential of human resources in the Visegrad regions. *Journal of Business Economics and Management*, 22(4), 1026–1046. DOI: https://doi.org/10.3846/jbem.2021.14541

Mladenov C. (2016). Demographic potential and problems of the settlements network in the mountains of Bulgaria. In: Zhelezov G. (Ed.). *Sustainable Development in Mountain Region*s. Cham: Springer. DOI: 10.1007/978-3-319-20110-8_15

Pastuszka S. (2017). Regional differentiation of the demographic potential in Italy and Poland. *Comparative Economic Research-Central and Eastern Europe*, 20(3), 137–159. DOI: 10.1515/cer-2017–0024

Sobczyk A., Archuadze Z. (2016). Assessment of demographic potential of the Tbilisi Metropolitan Area with the use of synthetic variable. *Folia Pomeranae Universitatis Technologiae Stetinensis. Oeconomica*, 85, 147–158. DOI: 10.21005/oe.2016.85.4.15

Sojka E. (2012). Demographic potential of the countries that have applied for the European Union membership. *Bulletin of Geography. Socio-economic Series*, 17, 135–145. DOI: 10.2478/v10089-012-0014-4

Stojanović J., Kokotović-Kanazir Vl., Stojanović M. (2017). Does small town with touristic function have demographic potential? *Journal of the Geographical Institute "Jovan Cvijic"*, 67(2), 145–162. DOI: 10.2298/IJGI1702145S

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