Prediction of the demographic situation in urban districts as a factor of sustainable social and economic development of the transport infrastructure

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Abstract. Article considers the significance of the demographic forecast for the effective operation of the providing system of social and economic development of the urban transport infrastructure. Analysis of the factors which influence on the population of the city of Voronezh was performed and the population forecast for the year 2020 is presented on the basis of the classification by year of birth. Calculation was performed in three variants (with consideration of the use of classification by year of birth) in connection with an impact of modern social and economic situation on the negative tendencies formed in demographic processes. In the basis of variants were grounded different approaches to the dynamics of demographic processes. The main demographic indicators are the number of permanent residents, birth rates, death rates, migration rates. According to the results of the study, population of the urban district of the city of Voronezh is expected to increase in the specified period and migration inflow of the population has a dominant role in the formation in the formation of the number of the city population.

1. Introduction

Sustainable development of the state, region, county, city is impossible without objective assessment and forecast of innovation-active resources [1] including labor, and, consequently, demographic situation as a whole. Many scientists agree that, despite the urgency of the problem, insufficient attention is paid to the demographic issues in Russia [2]. Instability of the social and economic living conditions of the population, its reproductive behavior expressed in conscious restriction of childbearing, deterioration of public health, high level of mortality especially in working age, increase in the number of divorces, increasing impact of housing conditions on fertility and many other factors lead to the complex demographic situation in cities. Marked positions lead to difficulties which arise in the process of development of the effective transport infrastructure of territorial formation [3], first of all, of the city, both from the point of view of the condition of the labor market of specialists [4], and from the target audience, on which transport infrastructure is oriented in and of itself.

With consideration of the mentioned problem, the purpose of our research performed on the example of Voronezh urban district (hereinafter referred to as Voronezh) there appeared the necessity of determination of the forecast number of the city for the period to 2020-2021.

2. Materials and Methods

Number of resident population in Voronezh was examined according to the data of the Territorial Body of Federal Government Statistical Service in Voronezh Region (Voronezhstat). Analysis of population

dynamics of Voronezh reflects the decrease in population to 2008. Main demographic factor which affected on the shortage of population in this period is natural population decline at the expense of sharp decrease in the birth rate.

Analysis of the dynamics of indicators in 2009-2016 indicates about increase of population on 114.6 thousand people (12.4%) in Voronezh urban district. Number of permanent residents of the urban district of Voronezh as of January 1, 2017 amounted 1038674 people.

Formation of the population of the city occurs at the expense of two sources of growth (loss): natural and migration. It should be noted that in recent years, at the expense of migration increase in the population (settling of refugees and displaced persons in the city), there has not been a sharp decrease in the population of the city. Nowadays, there are tendencies in demographic processes for migratory resettlement of people in the number of which dominates the working-age population.

Coefficient of migration exchange has positive dynamics and compensates natural decrease of population in recent years. Territorial activity of population is caused by the internal migration. Internal migrations compose nearly 62% of the migration exchange (intraregional -56%, interregional -34%). Persons who are the most capable of economic and reproductive age dominate in composition of the migration exchange.

Demographic method was used at the prediction of the population of Voronezh [10]. At that calculation was performed in three variants (with consideration of the use of classification by year of birth) in connection with an impact of modern social and economic situation on the negative tendencies formed in demographic processes. In the basis of variants were grounded different approaches to the dynamics of demographic processes.

First variant of prediction of the population is based on the prolongation of indicators of the dynamics of natural and migratory movement of the population, considering the possible change in demographic situation. Forecast of the population of the city is based on the analysis of the demographic and migration situation for retrospective period. Prediction calculations allow to assess the influence of fertility, mortality and migration on the future structure and population of the city. In predictive calculations of fertility intensity indicator, total fertility rate per 1000 inhabitants, was adopted for basic. In calculations of the birth rate laid a gradual increase in the total fertility rate (at the end of the calculation period, the total fertility rate may reach 16.2 ‰). In the process of population reproduction, in the process of the generation change, mortality, along with fertility, also plays a key role. Mortality rate of the population is the main criterion for characterization of the level of public health [5].

Perspective calculations of the number of population of the city are aimed at the decrease or mortality rates at the expense of: reduce of the premature mortality from all causes at the expense of its preventable part; gain in health of newborns and reduce of the infant mortality, reduce of the frequency of socially significant and socially-related diseases (tuberculosis, alcoholism, drug addiction, etc.).

But for the short period of time it is impossible to change negative consequences of past years: condition of health and environment, social and economic changes in the life of every person. Increase in mortality is expected in this connection. In 2020 overall mortality rate is projected in amount of 12,7‰.

Performed predictive calculations in fertility and mortality allowed to determine the magnitude of natural population growth in amount of + 3.5 ‰ for the estimated period, positive dynamics in natural growth is expected from 2017.

3. Results

Migration plays a significant role in formation of the population of the city; usage of the migration potential is the only factor which compensates natural decline in population to 2017. Nowadays, population of the city forms at the expense of migration growth. These are the residents of the region, refugees and internally displaced persons, military men.

With consideration of the forecast of fertility, mortality, natural increase, and the migration inflow, the population forecast is presented in Figure 1.

So, the period of 2017-2020 years characterizes by the natural population growth, conditioned by the increase of fertility and decrease in mortality, and the slight reduction in migration inflows is predicted too. Population of the urban district of Voronezh is expected to increase to 1103.3 thousand people for the indicated period. And in this period, the migration flow of the population will play a key role in the formation of the population of the city.

Second variant of the prognosis of prospective population of the urban district of the city of Voronezh is based on scientific developments of the Russian Academy of Public Administration under the President of the Russian Federation and the Institute for System Analysis of the Russian Academy of Sciences on demography [6,7].
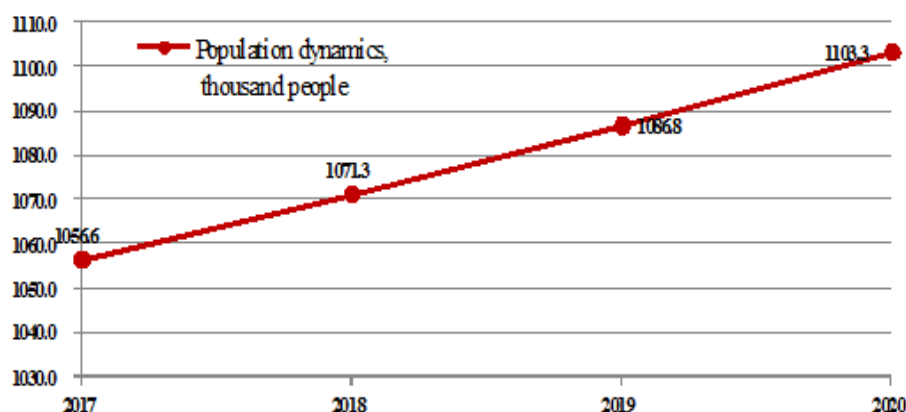

Figure 1. Population size forecast (I variant)

One of the main components of the process of population reproduction is fertility. System of indicators which allow to determine the general level and dynamics, intensity, and magnitude of fertility in different demographic groups is used for measurement of the fertility rates. Since the level of fertility cannot be judged by the absolute amount of births, therefore, a shift to relative fertility, namely fertility rates, which would not depend on the population, is necessary. This is the general fertility rate, a special fertility rate, age-specific fertility rates and a total fertility rate [8].

For elimination of the influence of demographic and other structures on fertility rates, its special and partial coefficients, and total fertility rate (Table 1) are calculated.

Table 1. Prediction for fertility.

Indicator	2017	2018	2019	2020
Total fertility rate	1.38	1.43	1.48	1.55
Special fertility rate	49.3	49.7	50.7	52.1
General fertility rate	14.2	14.4	15.2	15.8

Total fertility rate is equal the sum of age coefficients. It characterizes average number of births for a woman in her entire life with maintenance of existing levels of fertility. This is more accurate measure of the fertility rate. Total coefficients above 4.0 are considered high, less than 2.15 are low.

Total fertility rate is the only demographic indicator which has its normative amount which corresponds to the simple replacement of generations - 2.15, in calculation for abstract woman. In the prediction of fertility in urban district of Voronezh for the period of 2017-2020 total fertility rate is adopted as fundamental.

Mortality along with fertility plays a key role in the process of reproduction of population. It is the most sensitive indicator of changes in quality of life.

The first relative indicator of the mortality rate is general mortality rate. It is both its special coefficient as all people are mortal.

General indicator of mortality is not universal because of its dependence on the sex and age structure of the population. At analysis of mortality, it must be intended, that age is a constant factor which makes

a great deposit in the amount of probability of mortality. Age-specific mortality rates occupy the most important place among private mortality rates and are calculated both for the whole population, and separately for men and women.

Measures aimed on the improvement of the work of the health care system in the nearest future should lead to the improvement in health of the population of the Russian Federation and, ultimately, to increase in fertility and increase in life expectancy. This circumstance is fundamental in forecast of the calculated population of the city of Voronezh on 2020 (table 2).

Estimated value of total coefficient in 2020 amounts 1.55 children per woman, that is less than the normative value which corresponds to the simple replacement of generations.

Table 2. Forecast of the population of the urban district of the city of Voronezh to 2020 (variant II).

From 01.01.	Total fertility rate	Special fertility rate, ‰	General fertility rate, ‰	General mortality rate, ‰	Migration rate, ‰	Population size, thousand people
2017	1.38	49.3	14.2	12.8	12.7	1056.6
2018	1.43	49.7	14.4	12.8	12.6	1071.5
2019	1.48	50.7	15.2	12.7	12.5	1086.7
2020	1.55	52.1	15.8	12.7	12.4	1103.0
2021						1120.1

Calculation of the total mortality rate is based on the following hypothesis: from the mid of 2000 there began a new stage in Russia. It characterized by the marked increase in the life expectancy of the population. In general, life expectancy in the Russian Federation increased in the 2000 on 5.43 years for men and on 3.71 years for women. This trend is not provoked with the market factors, but developed on the background of a system of measures characterized by continuity and a complex character; it is determined by the reduction of losses on the whole age scale from children to older persons; at the expense of all the main causes of death. All this gives grounds to expectation of the maintenance and development of positive dynamics of the life expectancy of the population in the conditions of further realization of politics on the development of human potential in the Russian Federation in whole and in certain regions and urban centers. Thus, magnitude of the mortality rate amounts 12.7 ‰ to 2020.

Forecast of the coefficient of migration growth considers the present situation in the dynamics of city population movement in the city of Voronezh, which is characterized with decrease of intensity of the migration process. Migration population growth rate is projected to decrease from 14 ‰ at the beginning of the project period to 12.4 ‰ at the end of the estimated period to 2020.

Population of the urban district of Voronezh is expected to increase to 1120.1 thousand people for the indicated period to 2021 by the second variant.

The third variant. For the purpose of comprehensive analysis of demographic situation in Russia aimed on the determination of causes which condition negative aspects in demographic situation, assessment of the possible reserves for the fertility increase, decrease of mortality and increase of the life expectancy, optimization of migration processes, and forecast of demographic situation in regions from 2012. Ministry of Labor and Social Protection of the Russian Federation published Methodological Recommendations on the development of programs of regional demographic development programs, according to which the classification by year of birth is declared as the main method of the population prediction.

Essence of the method is that the initial population as it were "moves" into the future, decreasing at the expense of dead (and retired) and replenishing at the expense of the born (and arrived). Therefore, for prediction it is necessary to know the basic number and structure of the population and the hypotheses, which regard to reproduction and migration of the population in the forecast period.

Population by sex and age was taken as initial one (separately for women and men in a one-year age group for each year of age) at the beginning of the base year from which the forecast is based.

The main thing in demographic forecasting is the determination of promising hypotheses of possible changes in fertility, mortality and migration. The degree of accuracy of the forecast is almost entirely

dependent on the verity of their prediction. Hypotheses are developed on the basis the demographic trends analysis. Hypotheses regarding fertility prospects are considered in the prediction through the age-specific fertility rates. Age-specific fertility rates are used in the one-year age group in the forecast. Hypotheses in regard of the mortality perspectives are manifested through age-specific mortality rates. Predicted age-specific mortality rates (separately for men and women) are determined on the basis of preservation of trends for the previous years. Hypotheses regarding the prospects of migration are considered in the prediction calculations through the indicators of the balance of migration by an age and gender groups.

Prospective total population, amount and proportion of the population of all age and gender groups are determined as a result of the forecast. Besides, the number of births and deaths, natural population growth and migration are calculated in the forecast. All these indicators are calculated both in absolute value and per 1000 population, that is general coefficients of fertility, mortality, natural and migration growth are determined.

Population forecast of the urban district of the city of Voronezh according to the classification by year of birth is graphically shown in the figure 2.
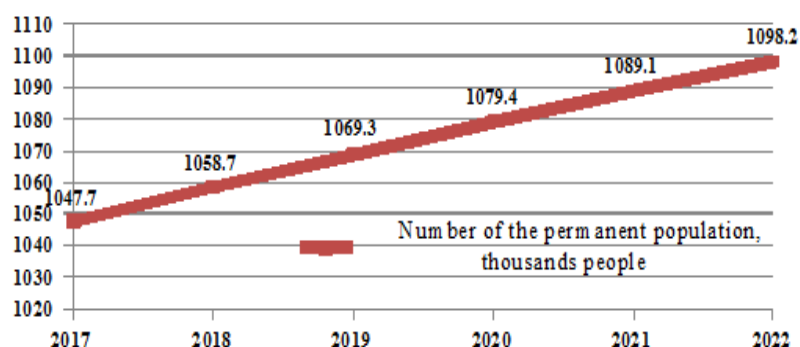

Figure 2. Forecast of the population of the urban district of the city of Voronezh by the classification by year of birth (version III).

Thus, according to the classification by year of birth population will be 1079.4 thousand people to the beginning of 2020. Obtained results can be compared with the indicator of size of the permanent population at the beginning of 2020 approved by the Annex to the Decision of the Voronezh City Duma from 10.07.2013 No. 1226-III "On amendments of changes in the decision of Voronezh City Duma from 14.07.2010 No. 147-III "On the Strategic project of the social and economic development of the urban district of the city of Voronezh for the period to 2020", amount of which is 1050.1 thousand people. Deviation of calculated data from indicator amounted 29, 3 thousand people.

4. Discussion
Demographic structure of the urban population of the city of Voronezh refers to the regressive type. Proportion of children and adolescents is steadily declining. However, the proportion of the population of older ages is quite high. On the one hand, there occurs a threat of a reduction in the proportion of economically active population in its total amount, on the other hand of the aging of the population.

Problem of the aging of the population of the city is extremely urgent, as the growing aging of the population of the city poses serious socioeconomic problems, including the problems of increase of the economic burden on society, necessity of consideration of changes in the level and character of consumption which corresponds to the adaptation of the infrastructure of the city as a whole, transport and other life support systems.

Forehanded preparedness for marked positions can be considered as the main condition for the successful overcome of the crisis phenomena. With the purpose of the eventual fuller accounting of features of the development of demographic processes in a research at the prediction of the population

of the city of Voronezh there was performed a calculation in three versions, that is connected with the significant impact of the modern social and economic situation on the pointed development.

So, the period of 2017-2020 years characterizes by the natural population growth, conditioned by the increase of fertility and decrease in mortality, and the slight reduction in migration inflows is also predicted according to the data of the research. According to the first variant, population of the urban district of Voronezh is expected to increase to 1103.3 thousand people for the indicated period. And in this period, the migration flow of the population will play a key role in the formation of the population of the city. Population of the urban district of Voronezh is expected to increase to 1120.1 thousand people for the indicated period to 2021 according to the second variant.

According to the third variant of calculation, the performed research allows to conclude that at increasing of size of the permanent population of the city of Voronezh to 1098.2 thousand people to 2022, number of persons of working age will make more than 650 thousand people, that at the appropriate level of qualification, competencies, innovative activity will provide the sustainable development of the city and region. Obtained results were compared with indicator of amount of permanent population at the beginning of 2020, approved by the Annex to the decision of the Voronezh City Duma "On the Strategic project of the social and economic development of the urban district of the city of Voronezh for the period to 2020", amount of which is 1050.1 thousand people.

5. Conclusions

Presented prediction of the demographic situation in the urban district of the city of Voronezh testifies that tendency of increase of population on 65 thousands people in average to 2020, in connection with this municipal authorities have to take specific decisions on optimization of the road and transport infrastructure.

Basic solutions of increase of efficiency and stable development of the road and transport infrastructure can be following:

- expansion of urban roads at the entrances to the city district and inside the city,

- optimization of the traffic flows on the central streets of the city (organization of one-way sections, introduction of reverse motion zones on the most busy roads, etc.)

- optimization of park and routes of city transport (renewal of bus fleets, optimization of routes, expansion of share of municipal public transport, etc.)

- development of the modes of passenger transportation alternative to the city transport (subway construction, increase of efficiency of the trolleybus fleet, etc.).

Through the sustainable development of the road and transport infrastructure, listed decisions allow ti increase the efficiency of the city transport network and, accordingly, quality of life of the population of the city district of Voronezh.

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