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STATISTICAL ESTIMATE OF QUALITY OF LIFE ECOLOGICAL DETERMINANTS

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Abstract

The strategic goal of the state policy in the ecological field is to support natural systems, preserve their integrity and functions that ensure sustainable development of our society, improve the life quality (population's health) and the demographic situation. The development of industrialization has led to a problem of limited resources and lack of them, and, as a result, the natural environment has become a threat to life and an obvious global problem for mankind. The consequence of the environmental degradation, first of all, becomes a low level of the life quality because of the deterioration of population's health, working and leisure conditions. The interconnection between economy, ecology, and the life quality predetermined the need for economic and statistical estimation of the degree to which environmental determinants influence the life quality in the Russian regions. In this regard, the following tasks were set in the study: to analyze the dynamics of environmental determinants, to perform multidimensional classification of the constituent entities of the Russian Federation according to environmental parameters; to identify and estimate the impact of environmental determinants on quality of life indicators through analytical groups. The typology of the regions on quality of life environmental determinants revealed that the bulk of the constituent entities of the Russian Federation (about 70%) were characterized by low and relatively low impact of quality of life environmental determinants in 2017. The construction of analytical groups allowed us to determine the most significant relationships between quality of life indicators and the main environmental determinants.

Keywords: Life quality, environmental determinants, multivariate analysis, analytical groups, statistics.

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1. Introduction

To achieve sustainable economic development, we need to implement an effective, focused structural policy of the state. The negative consequences of the country's economic growth are environmental pollution, deterioration of public health and much more. The main tool for ensuring sustainable economic development is the “green economy”, which is aimed at improving the quality of life and reducing environmental risks (Tereshina, Valvashov, Urmanov, & Bashmakov, 2019). Environmental estimate includes a system of actions, measures, as well as identification and analysis of quantitative and qualitative changes in various consequences of the negative impact of natural anthropogenic determinants on the quality of life.

2. Problem Statement

The analysis of scientific works showed that, despite the relevance of the topic under study, the regional aspect of the statistical analysis of quality of life environmental determinants has not been sufficiently studied yet. The analysis methods presented in the works are aimed mainly at measuring the degree of area contamination and possible socio-economic consequences.

A study of the relationship between ecology and economy when considering territorial planning and environmental policy, environmental costs of economic development was carried out in some scientific works (Bottero, Bravi, Giaimo, & Barbieri, 2020).

The relationship of environmental determinants and the quality of life of the region is presented by Bakanach, Proskurina, Sazhin, and Skvortsova (2016). The influence of economic growth and the state of the environment on public health (a component of the quality of life), expressed in life expectancy, is considered by Kosinsky (2015). Assessment of territories using an integral indicator reflecting the state of the environment, the quality of life, including the level of socio-economic development, is carried out many Russian scientists (Rozenberg, Lazareva, Kostina, & Rozenberg, 2019; Dmitriev, Kulesh, & Sergeev, 2019). Methodological approaches to include the environmental determinant in human development index characterizing the quality of life were proposed by Ryumina (2016), Kuznetsova and Ivashina (2020).

The nature and specifics of the impact of environmental indicators on social well-being, healthy lifestyles and life expectancy of people using the data of a sociological survey were studied in the work of Vasenina and Sushko (2018). The impact of regional differences in the well-being of population on gross domestic product in terms of environmental and social determinants was estimated by Bravi and Sichera (2016). In our opinion, the problem of statistical estimate of quality of life environmental determinants is certainly relevant at the regional level in the Russian Federation.

3. Research Questions

The following tasks are set in this study:

1. To perform a dynamic analysis of the main quality of life environmental determinants in Russia and its Federal Districts.

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2. To carry out a multidimensional classification of the constituent entities of the Russian Federation according to quality of life environmental determinants and identify the types of regions.

3. To identify and estimate the relationship of environmental determinants and the life quality.

4. Purpose of the Study

The purpose of the study is a statistical estimate of quality of life environmental determinants of the Russian Federation. The object of the study is the population in the constituent entities of the Russian Federation. The subject of the study is the quantitative characterization and identification of patterns in estimating quality of life environmental determinants of Russia and its regions.

5. Research Methods

The study was based on materials of the Federal State Statistics Service of Russia, Rosvodresursy, Rosprirodnadzor, Rostekhnadzor, as well as scientific publications on the subject under study. The methodological and theoretical basis of the study consists of laws and other regulatory acts of the Russian Federation, the work of domestic and foreign experts on the statistical study of the quality of life and the environment.

The following methods were used in the work: statistical summary and grouping, methods for analyzing generalized indicators, time series analysis, methods of multivariate statistical analysis. The most appropriate method of multidimensional classification is cluster analysis, which allows you to group regions by a wide range of indicators. Clustering consists in splitting a given sample of objects into subsets called clusters, so that each cluster consists of similar objects, and objects of different clusters are significantly different. Cluster analysis does not impose any restrictions on the type of objects under consideration, and allows you to consider a lot of input data of almost arbitrary nature.

The method of analytical groupings was used to identify the presence and relationship between environmental determinants and quality of life indicators in the regions of the Russian Federation. The advantage of this method is that it does not require compliance with any conditions of use, except for the qualitative uniformity of the studied population.

6. Findings

The theoretical analysis revealed that quality of life environmental determinants are as follows: volume of pollutant emissions into the atmosphere (X_1); volume of wastewater discharged into surface water bodies (X_2); volume of freshwater use (X_3); volume of waste generation of production and consumption (X_4); share of urban population with high and very high levels of air pollution (X_5). For comparability of indicators for inter-regional comparisons, all environmental determinants are taken per 10,000 people, except for the share of the urban population with high and very high levels of air pollution.

For the period 2011-2017, the volume of pollutant emissions into the air in Russia and in the regional context (except for the Far Eastern and Siberian Federal Districts) decreased. The largest volume of emissions is observed in the Urals and Siberian Federal Districts (an average of 5345.2 tons and 4016.4

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tons per 10,000 people, respectively). The lowest level of air emissions is observed in the North Caucasus Federal District (an average of 1,198.3 tons per 10,000 people).

In all Federal Districts, a decrease in wastewater discharge is also observed. The largest volume of wastewater discharges to surface water bodies was recorded in the Northwestern Federal District (an average of 2.12 million m^3 per 10,000 people), the least wastewater discharges were recorded in the North Caucasus Federal District (0.44 million m^3 per 10,000 people).

Most of all, fresh water is used in the Northwestern and North Caucasus Federal Districts (an average of 7.9 million m^3 and 7.5 million m^3 per 10,000 people, respectively). The least fresh water is used by residents of the Far Eastern Federal District and the Central Federal District (an average of 2.7 million m^3 and 2.6 million m^3 per 10,000 people, respectively). In all Federal Districts and in Russia as a whole (except for the Southern and North Caucasus Federal Districts, where fresh water is used for irrigation and agricultural water supply and for industrial needs).

The volume of waste generated by production and consumption has a negative trend - with each year the volume of waste in Russia increases. The maximum level of waste generation was recorded in the Siberian Federal District (an average of 1792.13 thousand tons). The minimum volume of waste generation is in the North Caucasus Federal District (an average of 2.54 thousand tons per 10,000 people).

To conduct multidimensional classification of the constituent entities of the Russian Federation according to quality of life environmental determinants (X^1.....X^5) and to identify groups of regions with similar characteristics, an information database was formed on 85 entities of the Russian Federation for 2017. Cluster analysis using the k-means method was performed in application software Statistica 13.3.

The worst quality of life environmental determinants are characterized by 10 regions of the 1st cluster, most of which are representatives of the Northwestern Federal District (the Republic of Karelia, Komi, Nenets Autonomous Okrug, Arkhangelsk and Murmansk Regions), as well as Irkutsk, Kemerovo and Magadan Regions, Yamalo-Nenets and Chukotka Autonomous Districts. This cluster has high volumes of pollutant emissions into the atmosphere, wastewater discharge into surface water bodies and waste generation of production and consumption.

The second cluster in terms of the impact of environmental determinants on the quality of life is occupied by the fourth cluster, which includes 16 constituent entities of the Russian Federation, mainly from the Central, Siberian, and Far Eastern Federal Districts: Voronezh, Kursk, Ryazan, Novgorod, Rostov, Kurgan, Chelyabinsk, Amur, Sakhalin Oblast, the Republic of Dagestan, Buryatia, Tuva, Khakassia, Altai, Krasnoyarsk and Transbaikal Territories. This cluster is characterized by a high proportion of the urban population with a high and very high level of air pollution, as well as the average waste generation of production and consumption per capita.

The second cluster, the largest (55 regions), in which all values of environmental determinants are below the average level concerning the reduction in the impact of environmental determinants. It includes entities of almost all Federal Districts, except for the Northwestern and Urals Districts. The cluster has the lowest emissions of pollutants into the atmosphere and freshwater use.

The 3rd cluster turned out to be the best in terms of quality of life environmental determinants and the smallest (4 regions): Kostroma, Vologda, Leningrad regions and the Khanty-Mansi Autonomous

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Okrug. These entities illustrate the smallest volumes of wastewater discharges to surface water bodies and waste generation of production and consumption and the largest volume of freshwater use.

Thus, the bulk of the regions of Russia (69.4%) can be characterized as regions having relatively safe environmental living standards. Analytical groups were built to identify the influence of environmental determinants on the quality of life of the regions of Russia. The following quality of life indicators were taken for productive indicators: incidence per 1000 people, life expectancy, birth rates, mortality and infant mortality rates.

Previously, a diagnosis of the uniform totality of the regions of the Russian Federation was carried out for each determinant basis. Groupings were built at equal intervals; the number of groups was established taking into account the variability of values of determinant attributes. The significance of the relationship was estimated based on the calculation of the empirical correlation relation.

One of the main environmental indicators is the emission of pollutants into the air, which affect the quality of live, namely the level of the incident rate. The influx of harmful substances into the atmospheric air (dust, sulfur dioxide, nitrogen oxides, carbon monoxide and hydrocarbons) mainly comes from the activities of industrial enterprises and vehicles. The relationship between the volume of emissions and the incidence rate (per 1000 people) in the regions of the Russian Federation is confirmed by the following grouping (Table 01).

Table 01. Dependence of the incidence rate of the regions of the Russian Federation on the volume of pollutant emissions into the air per capita

Groups of regions by level of air emissions, t / person	Number of regions	Average air emissions, t / person	Average incidence rate, ppm
Up to 0,101	9	0,05	610,7
0,101 - 0,256	53	0,18	791,1
0,256 - 0,411	13	0,33	828,5
0,411 - 0,566	3	0,49	995,4
0,566 and higher	7	0,68	1028,7
Total:	85		

Source: compiled by the authors based on data of Federal State Statistics Service (2019).

The results of the grouping allow us to conclude that the incidence rate increases with an increase in the volume of emissions of pollutants into the air per capita in groups of regions. The determination coefficient indicates that 77.7% of the interregional variation in the incidence rate is characterized by a variation in the volume of pollutant emissions into the air. The relationship between quality of live indicators and environmental determinants affecting them is presented in Table 02.

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Table 02. Relationship between environmental determinants and quality of live indicators

Environmental determinants	Quality of live indicators				
	Incidence rate	Life expectancy	Birth rate	Mortality rate	Infant mortality rate
Volume of emissions of pollutants into the atmosphere t / person	0,882	0,811	0,817	0,820	0,569
Volume of wastewater discharge m^3 / person	0,486	0,392	0,870	0,757	0,753
Volume of freshwater use m^3 / person	0,497	0,309	0,565	0,665	0,507
Volume of waste generation of production and consumption, t / person	0,761	0,602	0,479	0,563	0,535

Source: authors based on data of Federal State Statistics Service (2019).

The volume of pollutant emissions into the atmosphere has the greatest impact on all quality of live indicators, and there are close strong ties (> 0.8). Birth rate, mortality, and infant mortality rates are the most dependent on the volume of wastewater discharges into surface water bodies. The volume of freshwater use is closely correlated with the mortality rate (0.665). The closest relationship (0.761) was found between waste generation of production and consumption and incidence rate.

7. Conclusion

1. The dynamics of quality of life environmental determinants showed that the volumes of pollutant emissions into the atmospheric air, wastewater discharges, and freshwater use tend to decrease, which indicates an effective state policy to improve the environmental situation in the Russian Federation and its Federal Districts for the period 2011-2017. A negative fact is the growth in waste generation of production and consumption.

2. The results of cluster analysis indicate interregional differentiation by quality of life environmental determinants. About 70% of all entities are characterized by low and relatively low environmental impact on the quality of life.

3. Analytical groups have revealed that quality of life indicators are associated with a variety of strong and moderate direct and feedback links with the main environmental determinants that can serve as quality of life indicators in the regions of the country.

Despite the fact that relative well-being is observed in terms of quality of live environmental determinants in many Federal Districts of the Russian Federation, a negative effect occurs in 30% of the regions. The authorities need to continue to develop a set of measures aimed at improving the environmental situation in Russia in order to improve the quality of life.

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