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Comparison of Environmental Comfort in Rural and Urban Areas

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Abstract: The work assesses the comfort of urban and rural environment, which remains unstudied due to the lack of available research methods. Adapted methods of assessing the comfort of urban environment are used to analyze their applicability to rural areas. Due to the lack of research on the quality of rural environment, it is necessary to create research methods that allow for an objective assessment of the quality and comfort of rural areas using criteria that take into account their main characteristics. Functional zoning of the territory of settlements is a fundamental tool of urban planning that determines the spatial organization of the community's life. Its essence lies in the differentiation of urban or rural territory into zones with predominantly homogeneous land use and dominant activities. The analysis of functional zoning allowed us to identify the main functional zones within the study areas and calculate their areas. The assessment of the criteria for visualizing residential development in the study areas revealed that the quality of the visual environment in both areas meets the II category (acceptable). This means that the concentration of harmful visual fields does not exceed the concentration of comfortable ones. The calculation of the environment quality index revealed that the quality of the environment in the studied areas is generally at the same level, but there are significant differences in the criteria for assessing the quality of the environment. It is proposed to use adapted authorial methods to assess the comfort of rural areas: a method of calculating the quality index of the environment in rural settlements and private urban areas located far from infrastructure facilities, which is based on the methodology for calculating the quality index of urban environment approved by the Government Order; and a method for calculating the quality coefficient of the visual environment. This is done by calculating the ratio of the length of the route with harmful visual fields to the total length of the route being studied.

1 INTRODUCTION

The comfort of living environment remains a key issue for urban and rural areas in the Russian Federation. Many settlements fail to meet the basic needs of their residents, violating their right to safe and favorable living conditions. These conditions include environmental quality, access to infrastructure, social well-being, and aesthetics. The imbalance between natural and anthropogenic elements in urban landscapes leads to environmental degradation.

In the context of rural areas, the assessment of environmental quality is currently an understudied problem. Additionally, there are no scientific terms that define the quality or comfort of rural environment. However, since Russia has officially introduced the concept of "urban environment quality," which is defined as the ability of urban environment to meet the objective needs and demands of city residents in accordance with the current norms and standards of living, the quality of rural environment can be defined similarly. Therefore, the quality of rural environment can be defined as the

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ability of rural environment to meet the basic needs of its residents and maintain a comfortable standard of living.

Due to the lack of research on the quality of rural environment, there is a need to create methods for assessing the quality of environment, which will allow for an objective assessment of the quality and comfort of rural environment using criteria that take into account the main features of rural areas.

Rural areas are characterized by low building density, a predominance of green spaces for limited use over all other functional areas, and limited infrastructure, which often requires rural residents to travel to other settlements and cities to purchase necessary goods or services. The quality of life is particularly affected by the fact that many rural areas lack healthcare facilities and private clinics, making it difficult to access necessary medical care without leaving the area. On the other hand, compared to urban areas where the efficiency of emergency medical services is heavily influenced by traffic congestion, rural areas offer faster access to emergency medical care due to fewer traffic delays and lower call volumes. This fact proves that it is impossible to say that rural areas always lose to urban areas in terms of environmental quality, because many problems that are common in urban areas are not common in rural areas, and vice versa.

Dynamic aggressive visual fields, such as flashing textures consisting of black and white squares arranged in a checkerboard pattern, can also be dangerous for humans. When a person looks at these textures, they may perceive the squares as moving, even though the image is actually static. In human environment, the most common dynamic aggressive visual fields are traffic flows on major highways, where cars can form dense rows moving in different directions.

Based on the above-mentioned negative factors of modern human environment, it is easy to assume that the most comfortable visual fields for visual perception are those that are located outside of large cities with a large population, or in large green areas with minimal human intervention within urban landscapes. Natural visual fields in natural landscapes not only do not have a harmful effect, but can also have a positive impact on the nervous system, reducing stress and irritability.

In Russia, methods of assessing comfort are only developed for cities, which highlights the novelty and relevance of studying rural areas, which are often less well-equipped with infrastructure. When planning, it is crucial to strike a balance between technological impact and environmental conservation for sustainability.

Modern methods of assessing the quality of urban environments include the analysis of ecosystems (greening) and a comprehensive approach in natural, social, environmental and geochemical directions. Transport and noise pollution, an aggressive visual environment have a negative impact on the health of residents. The reduction of anthropogenic load is promoted by smart technologies (for example, air monitoring), the development of public transport, pedestrian areas and accessible infrastructure.

The relevance of this work is due to the fact that the assessment of the comfort of rural areas and private urban development areas in Russia has not been thoroughly studied to date, and there are currently no methods that are suitable for assessing the quality of these areas. However, private urban development areas and rural settlements currently require special attention in terms of environmental comfort, as the population tends to live in urban areas, resulting in overcrowding in cities. Therefore, it makes sense to create favorable conditions for people to live in rural areas. It should be emphasized that index-based methods for assessing the quality of environment in rural settlements are a powerful but complex tool. Their effective application requires a deep understanding of the specific features of rural areas, careful selection and justification of indicators, overcoming data challenges, and developing adapted aggregation methods. Despite the methodological challenges, the potential of such indices for objectifying the assessment of living conditions, identifying disparities, monitoring changes, and justifying the priorities for the development of rural areas is extremely high. Further research should focus on improving the methodology, testing, and implementing specialized indices of environmental quality for different types of rural areas, which will contribute to improving the validity of management decisions and enhancing the quality of life for the rural population.

2 MATERIALS AND METHODS

The object of research is the district Severniy of stanitsa Maryanskaya of Krasnoarmeysky district of Krasnodar Territory and the gardening cooperative

No. 1 within the boundaries of Krasnodar, the district Severniy. The area of the studied territory in the district Severniy is 42.25 hectares. The district is located in the northwestern part of the stanitsa, bounded on the south by Severnaya St., on the east and northeast by the A-289 federal highway, and on the north and west by the Angelinsky main water utility. The study area includes 293 land plots with an average area of 10 acres. The current population of the district is approximately 700 people.

The area of the gardening cooperative No. 1 in Krasnodar is 49 hectares. The territory is located in the western part of Krasnodar. The territory is bordered on the west by Zapadnaya St., on the south by Kalinina St., on the east by the territory of Kuban State Agrarian University named after I. T. Trubilin and the I. S. Kosenko Botanical Garden, and on the north by the territories of the Regional Clinical Hospital No. 2 and the Specialized Clinical Children's Infectious Diseases Hospital. There are about 670 plots of land with an average area of 6 acres in the gardening cooperative No. 1. The population of in the gardening cooperative No. 1 is currently slightly less than 2,000 people.

Geoinformation systems such as the Public Cadastral Map (PCM) of the Federal Service for State Registration, Cadastre, and Cartography (Rosreestr), available on the website of the National Spatial Data System (NSDS), were used to study the infrastructure and functional zoning of the territories under study; Google Earth program; Yandex Maps search information cartographic service; territorial planning documents of the municipal formation Krasnodar and the Maryanskaya rural settlement of Krasnoarmeysky district (maps of urban planning zoning), presented on the website of the Federal State Information System of Territorial Planning (FSIS TP). Calculations of the areas of functional zones and the share of these zones in the total area of the studied territories were carried out. Subsequently, the obtained data were structured and entered into summary tables.

The research process included route and visual studies, such as visiting areas to identify existing negative factors that degrade the environment.

Photographic recording of the studied areas was carried out in order to use the photographic materials in the study of visual environment and the analysis of the existing anthropogenic load. Only publicly accessible areas, streets, and public green spaces were subject to photographic recording.

The assessment of the quality of visual environment was carried out using V. A. Filin's methods in the field of video ecology, which were adapted for the purposes and objectives of this research. The quality of visual environment was determined in the "aggressiveness-homogeneity" system by determining the total concentration of visual fields that are aggressive and homogeneous, according to V. A. Filin's methods.

To use the existing methodology, which is designed for urban environments and predominantly multi-storey buildings, we introduced the visual environment quality coefficient (Veqc), which is an indicator that reflects the proportion of the length of aggressive and homogeneous (hereinafter referred to as harmful) visual fields in the total length of the studied route. The coefficient is calculated as the ratio of the length (in meters) of the route, which is characterized by the presence of harmful visual fields in the human field of vision, such as fences, building facades, and structures, to the total length of the selected linear route, using the following formula:

$$K_{\text{КВС}} = \frac{L_{\text{П}}}{L_{\text{М}}} \quad (1)$$

where $L_{\text{П}}$ – the length of the route characterized by the presence of harmful

visual fields, m;

$L_{\text{М}}$ – the total length of the selected route, m.

According to V. I. Filin's research, harmful visual fields have a negative impact on humans if the angle of visibility of these fields in the human field of vision is more than 15° horizontally and vertically. Therefore, the calculated value of the $L_{\text{П}}$ indicator in formula 1 includes the length of only those sections of the studied routes where harmful visual fields are in the person's field of vision, with horizontal and vertical viewing angles exceeding 15°.

Routes are selected on the paths of the most intensive pedestrian traffic within the boundaries of the surveyed territory. Several linear routes of intensive pedestrian traffic can be selected for one territory, in which case the total value of the visual environment quality coefficient of the surveyed territory will be the arithmetic mean of the visual environment quality coefficients of each selected route.

The concept of comfortable visual fields has been introduced. Comfortable visual fields are spaces or objects that do not have a negative or positive effect on a person when they are in the person's field of vision. Such visual fields include all green spaces,

most natural landscapes and objects (except for steppe, desert, and arctic landscapes, as well as homogeneous rock walls), building facades and fences with various decorative elements, and the sky.

The value of visual environment quality coefficient ranges from zero to one. The closer the value of the coefficient is to 1, the lower the quality of visual environment. The following scale of visual environment quality categories has been introduced to systematize the indicators:

I category (0,25 > Veq ≥ 0) – high quality of the visual environment (the concentration of harmful fields in the visual environment is minimal or completely absent);

II category (0,5 > Veq ≥ 0,25) – acceptable quality of the visual environment (the concentration of harmful visual fields does not exceed the concentration of comfortable visual fields);

III category (0,75 > Veq ≥ 0,5) – unsatisfactory quality of the visual environment (harmful visual fields predominate in the visual environment, while comfortable visual fields are fragmented)

IV category (1 ≥ Veq ≥ 0,75) – the worst quality of the visual environment (the visual environment consists mainly of harmful visual fields, and comfortable visual fields are either absent or fragmentary).

The calculation of the environment quality index was carried out using a methodology adapted for rural areas and private residential areas within urban areas. This methodology is based on the methodology for calculating the Urban Environment Quality Index (UEQI), approved by Order No. 510-r of the Government of the Russian Federation dated March 23, 2019, "On Approval of the Methodology for Calculating the Urban Environment Quality Index" (as amended on September 20, 2023), which was deemed irrelevant for assessing the quality of rural and private residential areas due to the focus of most indicators on urban multi-storey buildings. The methodology was adapted by reworking indicators that were irrelevant in rural areas and private settlements to make them more applicable for assessing the quality of the environment in rural areas and private settlements, as well as by adding new indicators that reflect aspects of the environment that were not included in the methodology for creating the UEQI. The indicators were divided into 4 groups according to the main criteria of environmental quality: quality of infrastructure (max. score – 80), quality of the environment (max. score – 80), environmental safety (max. score – 30), and sociocultural conditions (max. score – 40). The maximum number of points for the 4 criteria, which form the value of the environmental quality index, is 230.

Comparative analysis of the environmental quality in rural and urban areas using the example of the district Severniy of stanitsa Maryanskaya and the gardening cooperative No. 1 in Krasnodar was conducted on the basis of a generalization of the results obtained during all previous studies. All the advantages and disadvantages of the environment in the study areas were listed. Route and visual studies were taken into account along with other research methods. The result of the comparative analysis is a conclusion about which of the study areas has a higher overall quality of the environment.

3 RESULTS AND DISCUSSION

The analysis of the above-mentioned geoinformation resources allowed us to identify the main functional zones within the study areas and calculate their areas. The results are presented in Tables 1 and 2. The maps of urban planning zoning of the study areas, according to the territorial planning documents, are shown in Figures 1 and 2.

Table 1: Functional zoning of the research area in the district Severniy of stanitsa Maryanskaya.

№	Name of the zone and sub-zone	Area, m²	Share of the total area, %
1	Selitebnaya, including:	290983	71,56
1.1	Buildings, including:	34640	13
1.1.1	Residential buildings	30420	12
1.1.2	Social and public buildings	4220	1
1.2	Household plots	235434	64,34
2	Roads, including:	36986	8,76
2.1	Unpaved roads	24786	5,87
2.2	Paved roads	12200	2,89
3	Green spaces, including:	141944	33,6
3.1	of common use	58800	13,9
3.2	of limited use	83144	19,68

№	Name of the zone and sub-zone	Area, m²	Share of the total area, %
4	Lawns, meadows	188583	44,64
	Total area	422455	100,00

Table 2: Functional zoning of the gardening cooperative No. 1 in Krasnodar

№	Name of the zone and sub-zone	Area, m²	Share of the total area, %
1	Selitebnaya, including:	409948	83,67
1.1	Buildings, including:	113500	23,17
1.1.1	Residential buildings	110240	22,5
1.1.2	Social and public buildings	1250	0,26
1.2	Household plots	296425	60,5
2	Roads, including:	56170	11,46
2.1	Unpaved roads	44936	9,17
2.2	Paved roads	11220	2,29
3	Green spaces, including:	320285	65,37
3.1	of limited use	296425	60,5
3.2	of common use	23860	4,87
	Total area	489958	100,00

Figure 1: Urban planning zoning map of the district Severniy.

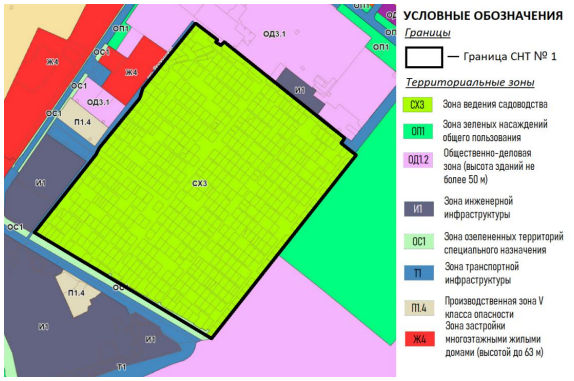

Figure 2: Urban Planning Zoning Map of the gardening cooperative No.1 in Krasnodar.

According to the data in Tables 1 and 2, it can be noted that the residential zone, which is represented by buildings and private plots, prevails in both areas under study, but in the gardening cooperative No.1 in Krasnodar, the share of the residential zone and residential buildings in the total area is higher than in district Severniy, which indicates a higher density of development in the gardening cooperative No.1.

The availability of green areas of common use within the boundaries of the surveyed territories is significantly higher on the territory of the district Severniy is 84 m² per person, which is much higher than the standard value for rural settlements, which is 12 m², according to the Code of Rules "Urban Construction". Such a high indicator is due to the low population of the district Severniy is characterized by the presence of a park with an area of more than 10,000 m²/person, as well as a significant area of landscaping on the streets.

In the territory of the gardening cooperative No.1 in Krasnodar, the provision of greened public areas is 11.93 m²/person, which exceeds the standard value of large urban settlements (10 m²).

At the same time, the gardening cooperative No.1 in Krasnodar significantly outperforms the district Severniy in terms of the territory of limited-use green spaces located on private house territories (296425 m² versus 58800 m²). However, the small territory of green areas of limited use is in the district Severniy. This is due to the fact that the planting of green spaces in the land neighborhood for residential housing began only in 2018-2019, when the neighborhood began to actively build up.

The share of unpaved roads is significantly higher in the territory of the gardening cooperative No.1 in

Krasnodar. There are no industrial or municipal storage areas within the studied territories.

To study the quality of visual environment in the district Severniy and the gardening cooperative No.1 selected the routes of the most intensive pedestrian traffic, on which the horizontal extent of harmful visual fields was calculated for further calculation of the visual environment quality coefficient. The selected routes were shown on the schematic maps shown in Figures 3 and 4.

To conduct a study of the quality of the district Severniy visual environment. One linear route with a length of 1.1 km was chosen, passing along a pedestrian paved road along Severnaya St. The average pedestrian traffic along this route ranges from 15-20 people per hour.

Two linear routes were selected for the gardening cooperative No.1 in Krasnodar, one of which runs along Vostochnaya St. (700 m), and the other runs along Tsentralnaya St. (780 m). There are no sidewalks or pedestrian paths in the gardening No.1, and pedestrians primarily use the roadways. The average pedestrian traffic intensity on Vostochnaya and Tsentralnaya streets is approximately 50 and 30 people per hour, respectively.

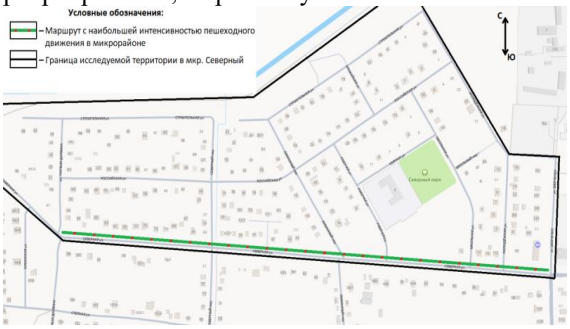

Figure 3: Map of the route with the highest pedestrian traffic in the district Severniy.

Figure 4: Map of the most intensive pedestrian routes in the gardening cooperative No.1.

The results of calculating the visual environment quality factors in the district Severniy and the gardening cooperative No.1 are presented in Table 3.

Table 3: Calculation of visual environment quality coefficients.

Estimated indicator	Territory under study		
	District Severniy	Gardening non-profit company No.1	
		Centralnaya St.	Vostochnaya St.
Route length characterized by the presence of harmful visual fields ($L_П$), m	320	230	280
Total route length ($L_М$), m	1100	780	700
Visual environment quality factor (V_{EQF}) of the studied route	0,290	0,295	0,400
V_{EQF} of the studied territory	0,290	0,347	

Based on the data in Table 3, it can be concluded that the value of the visual environment quality

coefficient for both study areas is between 0.25 and 0.5, which, according to the visual environment quality category scale, corresponds to category II – acceptable visual environment quality (the concentration of harmful visual fields does not exceed the concentration of comfortable visual fields).

The formation of the environment quality index is carried out by determining the environment quality indicators in points from 0 to 10, the total value of which is the desired environment quality index. The results of calculating the environment quality index of the studied territories are presented in Table 4.

Table 4: System for calculating the environmental quality index of the studied territories.

Parameter	District Severniy, score	Gardening cooperative No.1, score
Gardening non-profit company No.1		
Availability of public utilities (water, gas, electricity, and sewage)	6	8
Provision of trade and consumer services facilities	4	7
Availability of medical services	3	9
Share of streets with stormwater sewers/drains	5	5
Availability of sports grounds and facilities	7	0
Accessibility of public transport stops	5	7
Proportion of streets with roadway lighting	4	8
Road quality	7	5
Total for the group	41	49
Environmental quality		
Traffic intensity	8	4
Level of greening	10	10
Tap water quality	5	7
Atmospheric air quality	8	6
Level of physical pollution of the environment	9	7
Anthropogenic transformation of the landscape	8	7
Visual environment quality	8	7
Timely garbage collection and cleaning of the territory	7	6
Total on the group	63	54
Environmental safety		
Overall accident rate in the locality	9	4
Pedestrian safety near educational, healthcare, cultural, and sports facilities	8	5
Overall crime rate in the locality	8	6
Total on the group	25	15
Socio-cultural conditions		
Natural population growth	7	7
Share of residents living below the poverty line and unemployed people of working age	10	9
Share of residents who work outside their place of permanent residence	4	9
Educational potential	4	8
Total on the group	25	33
Total	154	151

Based on the results of the calculation of the environment quality indices for the study areas in the Severniy district and the gardening cooperative No.1, it can be concluded that the value of the environment quality index for the two study areas is approximately the same. However, the study revealed that, despite the similar final scores, the areas differ significantly in terms of the structure of the environment quality criteria.

In terms of infrastructure development, the urban area surpasses the rural area in terms of accessibility of medical services, road lighting and accessibility of public transport stops. However, the Severniy district is a leader in the accessibility of sports facilities and the quality of roads. This reflects the integration of the gardening cooperative No.1 into the infrastructure of Krasnodar, but the weak development of local facilities, whereas the Severniy district compensates for the limited services provided by landscaping elements.

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The quality of the environment on the territory of the Severniy district is higher due to low traffic load, better air quality and less physical pollution. Both territories have a high level of landscaping. In the gardening cooperative No.1, environmental quality is reduced by urban influence.

The countryside has an overwhelming advantage in terms of environmental safety, especially in terms of accident rates. Urban areas are disadvantaged due to high population density, transit traffic, and criminal risks.

According to the socio-cultural criterion, the gardening cooperative No.1 benefits from a significantly lower proportion of residents working outside their locality and educational potential. Indicators of poverty, unemployment, and natural population growth in the gardening cooperative No.1 and the district Severniy are the same. The city provides access to jobs and education, but the village maintains social stability.

4 CONCLUSION

The conducted study confirms the importance of developing new methods for assessing the quality of the environment in rural areas and private residential areas. Based on the results of calculating the environment quality index, it was found that the quality of the environment in the studied areas is generally at the same level, but there are significant differences in the criteria for assessing the quality of the environment. For example, the gardening cooperative No.1 has higher scores in terms of infrastructure quality and sociocultural conditions, while the Severniy district has higher scores in terms of environmental quality and safety.

To assess the comfort of rural areas, it is recommended to use adapted authorial methods:

– a methodology for calculating the quality index of rural settlements and private urban areas located far from infrastructure facilities, adapted based on the methodology for calculating the quality index of urban environments approved by the Government Order;

– a method of calculating the quality factor of the visual environment carried out by calculating the ratio of the length of the route characterized by the presence of harmful visual fields to the total length of the route under study.

The results prove that environmental comfort is a multidimensional indicator. Optimizing the quality of the environment requires taking into account the strengths and weaknesses of each territory, rather than using universal solutions.

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