

# Geoinformation support of the program "Integrated development of rural areas"

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**Abstract.** This work is devoted to the rural areas' integrated development issues. The advantages of a systematic approach for the sustainable development paradigm main policies' goals implementation and the possibility of using geoinformation technologies as a tool for multidimensional analysis of rural areas are considered. A two-stage methodology for monitoring the rural settlements development, which makes it possible to assess the territory at the federal and local levels by a set of indicators reflecting the main aspects of socio-economic processes, is proposed. Special attention is paid to assessing the quality of the environment by three groups of factors that take into account environmental comfort, movement comfort and other indicators characterizing the comfort of living from the point of view of the territorial residents' individual needs.

## 1 Introduction

The main goals of the Rostov region state program (hereinafter referred to as the state program) "Integrated development of rural areas" are:

- maintaining the share of the rural population in the total population of the Rostov region and increasing the average monthly disposable resources of rural households in relation to urban households;
- increasing the total area share for the comfortable residential premises in rural settlements.

It is noticeable that the goals of this state program exist within the framework of the sustainable development concept, which has certainly been evolved in its formation and existence over the past 40 years. Currently, the sustainable development concept is complex and complicated, taking into account various aspects of socio-economic and territorial systems [1].

The concept of sustainable development predetermines the use of a systematic approach to analyze and interconnect the socio-economic, historical, natural resource and ecological territorial components. The systematic approach makes it possible to interconnect and ensure the three related policies' goals implementation in accordance with the paradigm of sustainable development:

1. social policy (progressive improvement in the quality of social services, competitiveness growth of the social sphere in the struggle for human capital, etc.).
2. economic policy (balanced territorial economic development).

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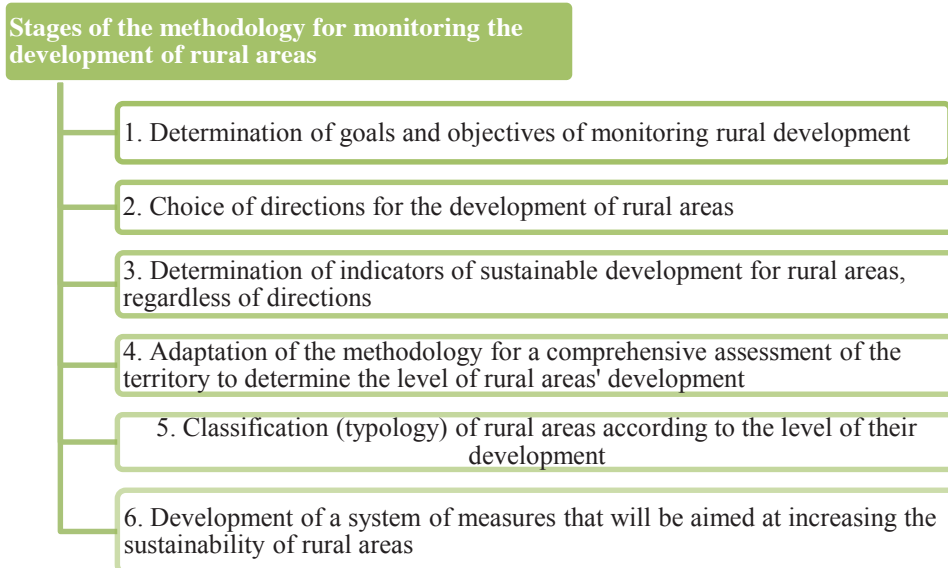
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3. spatial policy (creating conditions for comfortable living, developing a globally effective supporting territorial framework and preserving the ecosystem) [2].

For the systematic accounting of the above-mentioned components, it is proposed to use geographic information systems that have long been actively introduced into the processes of territorial development management, especially as a tool for spatial multidimensional analysis of territories.

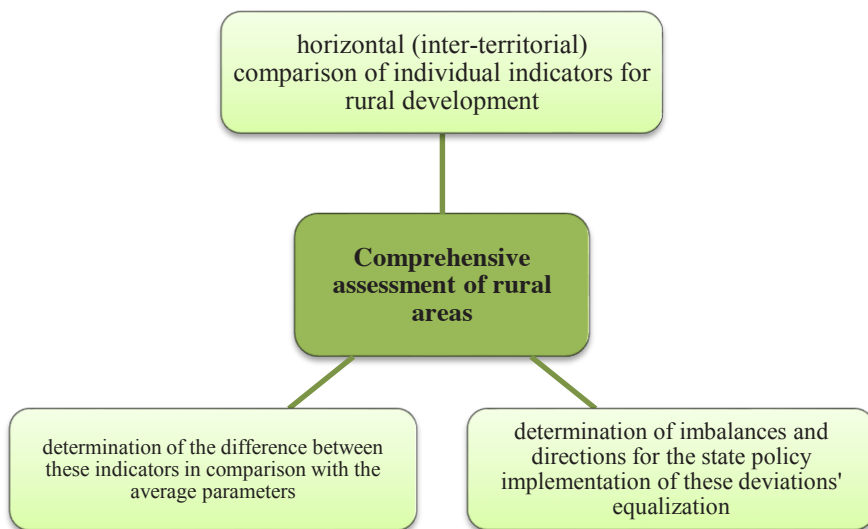
## 2 Theoretical part

One of the priority directions of the country's urban planning policy is to ensure the sustainable development of rural areas. An important criterion for achieving this is understanding the main problems and identifying the potential of each of the studied territories, which is possible only with regular monitoring of changes in the local socio-economic system state. Monitoring gives an opportunity to determine how effectively the state authorities and local self-government activities are carried out, to assess the investment attractiveness of the territory for business, to identify the population social well-being level. Constant monitoring permits collecting and structuring data on the main directions of development, which should be followed for optimal use of resources, stable development of rural areas and improving the population life (Fig. 1) [3].



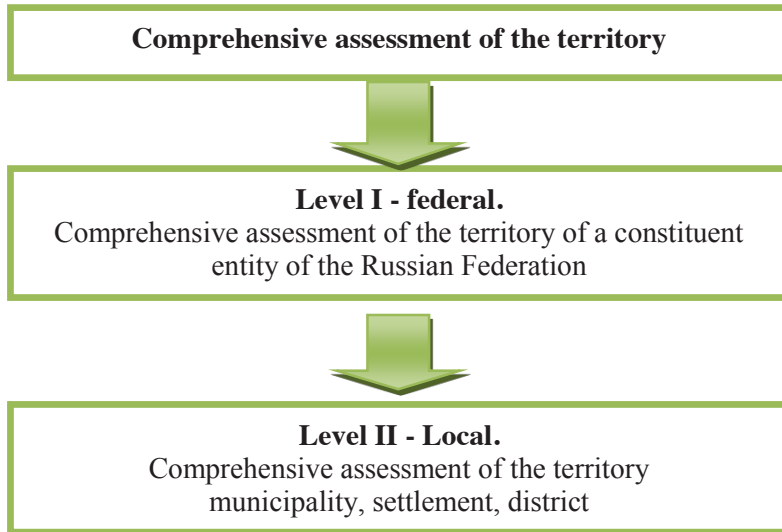
**Fig. 1.** The sequence of the technique implementation

A comprehensive assessment to obtain a general characteristic of the territory in terms of the main aspects of socio-economic processes is advisable to use as a tool for monitoring the development of rural areas. The essence of a comprehensive assessment of a territory consists in a multivariate analysis of qualitative and quantitative indicators of the state of territories with the subsequent formation of a generalized conclusion about the rural settlements socio-economic development results [4].



**Fig. 2.** Tasks to be solved using a comprehensive assessment of rural areas [5].

The developed system of multi-criteria assessment of the territory to create the conditions for comfortable life has a complex structure, respectively, it is supposed to be divided into two levels (Fig. 3).



**Fig. 3.** Hierarchical system of the rural settlements integrated assessment

Within the framework of ensuring the spatial integrity of the territorial system, namely, creating the conditions for comfortable life and the development of a globally effective supporting territorial framework, as well as preserving the ecosystem, the following series of comprehensive assessment factors for the constituent entities of the Russian Federation are proposed - I level:

Integral indicator for anthropogenic load (obtained by summing up the indicators of environmental impact: demographic, industrial, agricultural and transport impact on the environment) - F1;

Air pollution (the indicator takes into account the spatial distribution of the integrated air pollution index) – F2;

Assessment of the drinking water quality (consists of two components: the content of toxic substances and organoleptic properties, as well as bacteriological indicators)– F3;

The ecological potential of the constituent entity territories of the Russian Federation (consists of the following parameters: air temperature, relative humidity, precipitation, heat supply, biological productivity, considered as an indicator of local food and resource potential) – F4.

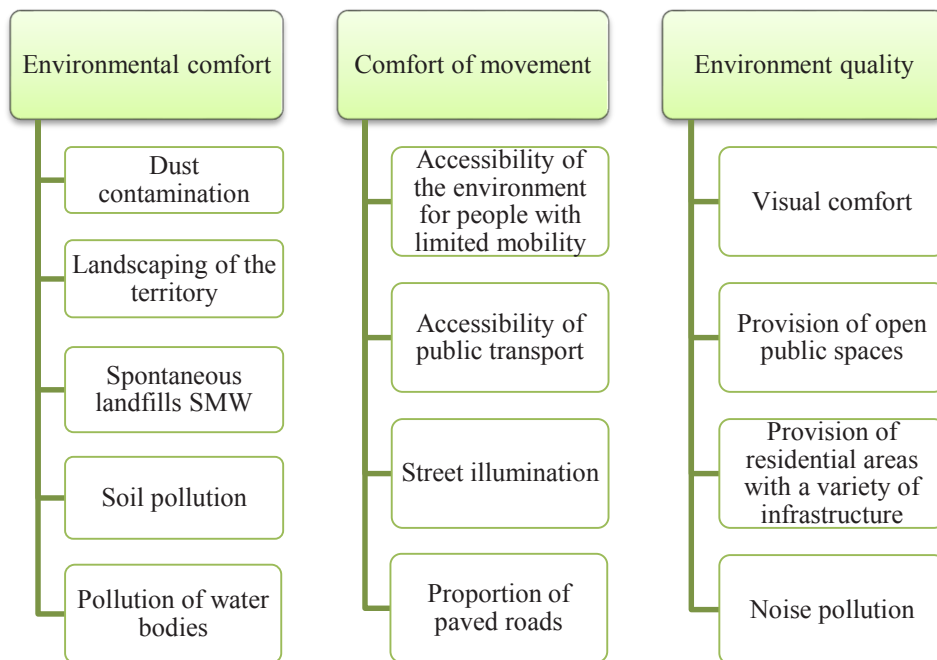
The results of a comprehensive assessment in the form of electronic maps for these factors are presented in the experimental part. Table 1 shows the classification of this group of assessment factors with the values ranking in points and their description.

**Table 1.** Classification of assessment factors level I.

| Fn | Factors                                                                              | Description                                                                                               | Values (estimated score)      |
|----|--------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------|-------------------------------|
| F1 | Integral assessment of anthropogenic load                                            | Situation:<br>Catastrophic<br>Crisis<br>Critical<br>Tense<br>Satisfactory                                 | 0<br>0.25<br>0.5<br>0.75<br>1 |
| F2 | Air pollution                                                                        | Environmental assessment by integrated air pollution index:<br><0,1<br>0,1-1<br>1-4<br>4-8, 8-16<br>16-32 | 1<br>0.75<br>0.5<br>0.25<br>0 |
| F3 | Drinking water quality assessment                                                    | Situation:<br>Crisis<br>Critical<br>Tense<br>Satisfactory                                                 | 0<br>0.33<br>0.66<br>1        |
| F4 | Ecological potential of the constituent entity territories of the Russian Federation | Situation:<br>Favorable<br>Relatively favorable<br>Unfavorable                                            | 1<br>0.5<br>0                 |

A comprehensive assessment of the II (local) level is aimed at a more detailed and in-depth study of the environment quality in the study area in order to increase the comfort of population living. The formation of a comfortable environment requires a systematic approach in order to comprehensively solve a large number of problems caused by urbanization, typical not only for the territories of megalopolises and large cities, but also for the territories of modern rural settlements. The improvement process and environment quality improvement should affect both the appearance of the settlement and the principles of territorial planning and development, and take into account the ecological situation.

Within the framework of this methodology, it is proposed to use the following three groups of level II assessment factors (Fig. 4).



**Fig. 4.** Assessment factors of the II (local) level

At the moment, many approaches to assess the quality of the environment have been developed however, none of them can be called universal. There are a number of difficulties associated primarily with the quantitative measurement of a number of factors that directly affect the quality of the environment, such as aesthetics, convenience, accessibility and other so-called "soft" factors that are subjectively assessed. Nevertheless, the most comprehensive picture of the state of the environment can be obtained only by examining both subjective and objective indicators of its quality. Objective quantitative characteristics show that the environment meets the minimum necessary requirements, while a high level of values of subjective indicators characterizes the environment as fully satisfying the requirements of quality and comfort of living in terms of the individual needs of residents.

One of the most important criteria for assessing the urban environment quality is the environment state. The acute problems of the ecology for the built-up areas include atmosphere and water bodies pollution, the state of green spaces and soil pollution, the lack of an established system of waste processing and spontaneous dumps. Continuing urbanization and development of natural areas leads to an increase in anthropogenic pressure on the environment and damages the environment. With an increase in population density, there is an extensive expansion of the territory of settlements, cities and agglomerations, and the volume of industrial and agricultural production also increases. This entails an increase in the building density, the formation of a technogenic environment and its saturation with transport and engineering infrastructure, as a result of which the ecological situation is significantly deteriorating.

Special attention should be paid to ensuring the movement comfort of people across the territory and the availability of an accessible or barrier-free environment that allows people with disabilities to lead an independent and comfortable lifestyle. In this case, we are talking not only about ensuring free movement and receiving services for people with

disabilities, but also about the accessibility of the environment for all low-mobility groups of the population (LMP), which also includes pregnant women, people with strollers, preschool children, temporarily disabled and elderly people. A serious obstacle to the comfortable movement of people on a particular territory is often the lack of paved roads and insufficient illumination of the streets, which is especially typical for rural areas. In order to increase the comfort of living, rural settlements should also be provided with convenient public transport both for local transportation and for communication with neighboring settlements and large regional centers.

In order to increase the comfort of living and the attractiveness of the territory for people, it is also proposed to consider such factors as visual comfort (regulation of outdoor advertising, the state of green spaces and landscaping, the condition of building facades, etc.), the presence of open public spaces of various infrastructure in residential areas, allowing to provide residents with a greater number of services, as well as the level of noise pollution.

These factors are proposed to be evaluated based on the results of environmental measurements, field studies and remote sensing data with subsequent construction of electronic maps. It is proposed to evaluate the factors in points for the aggregate analysis of all parameters of the natural environment of the city, measured in scales of different ranges and dimensions.

### 3 Experimental part

In order to use various types of maps and information, as well as to reduce labor intensity and increase the speed of processing, data analysis and calculations, for a comprehensive assessment of the territory GIS technologies. Modern geographic information systems and electronic mapping technologies make it possible to carry out a spatial analysis of urban planning systems, which is one of the reasons for their active implementation in the processes of territorial planning and management of the development of territories. For the practical implementation of a comprehensive assessment of the I level for the territory of the Rostov region, one of the leading products in this area was used - the ArcGIS software package from ESRI (USA).

To calculate the integral indicator  $FI$  - anthropogenic load is calculated according to the following formula 1:

$$FI = P+I+A+T \quad (1)$$

where  $P$  – anthropogenic load from the activities of the population, in points;

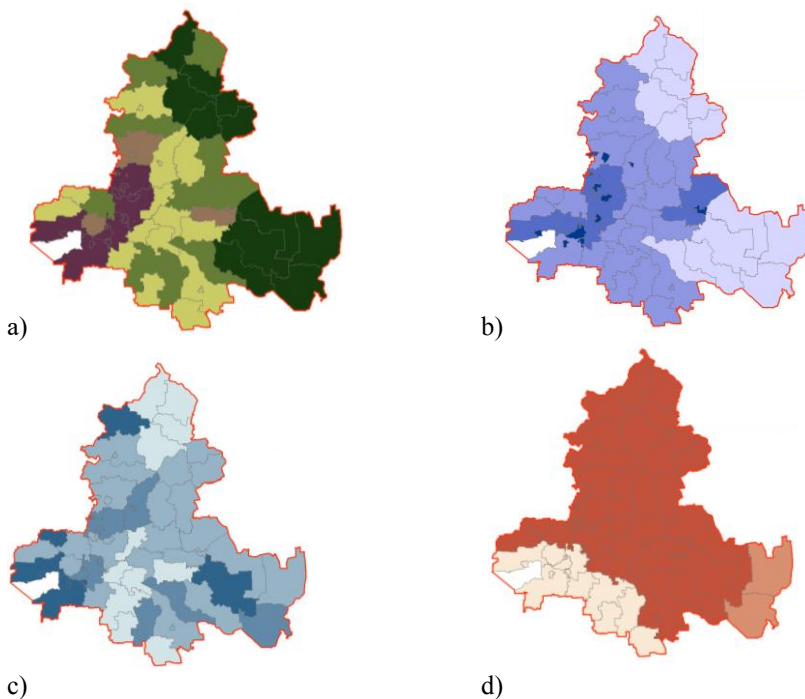
$I$  – anthropogenic load from industry, in points;

$A$  – anthropogenic load from the agro-industrial complex, in points;

$T$  – anthropogenic load from transport, in points.

The data sources for each indicator are the results of environmental monitoring of the Rostov region, which are interpolated into a point system from 0 (min) to 5 (max). Next, the resulting map of anthropogenic load is constructed (Fig. 5 a).

ESRI ArcGIS environment has built electronic maps for a comprehensive assessment of living comfort by factors  $F1$  –  $F4$  on for the Rostov region (Fig. 5).



**Fig. 5.** a) integral indicator for anthropogenic load, b) air pollution, c) assessment of drinking water quality, d) ecological potential of territories

At the next stages of the study, it is planned to build electronic maps and conduct a comprehensive assessment of the local level for several rural settlements of the Rostov region.

## 4 Conclusion

The developed methodology for monitoring the rural areas development makes it possible to assess the dynamics of their development by a set of factors that directly or indirectly take into account the spatial, economic and social criteria necessary to achieve sustainable territorial development.

An important feature is the inclusion of a number of factors for assessing the comfort of the environment, which are often used only for urban areas, however, no less important for providing residents of rural areas with a high-quality environment. Comfort of living is ensured by a certain set of qualities and functions of the territory, which create the most favorable and attractive living environment for residents. A high-quality saturated environment attracts professional and active people, which makes it possible to make not only the city, but also the rural settlement more competitive in the struggle for human capital.

The technique versatility is ensured by the possibility of its adaptation and application for any municipality or rural area.

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