

GIS and territorial planning

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Abstract

The article contains scientific research results of 3 studies: information model of territorial development process management; GIS and territorial planning; the methodology of strategic management of the educational institution location on the urban territories using the GIS – technologies.

The first study was connected with territory development, which is a difficult process of qualitative reorganization of national economy structure for creation the optimal population life environment. Within the framework of simulated modeling complex evaluation of territory is being effected, then on its basis the evaluation of potentials of the region and calculation of priority of kinds of functional use of the territory is being carried out. The latter calculates, what kinds of functional use will be mostly rational and useful for those and other territories, what finally will determine priority trends of development of separate territories. On each kind of functional use of territory the imitation model is being developed, with which you may determine the most attractive districts for corresponding kind of functional use of territory.

GIS is the main instrumental base for elaboration and functioning of the territory development imitational model. Present day GIS include almost all the necessary modeling instruments. They are: presentation of data as thematic layers, geometry modeling functions, competent mathematic apparatus, and data base management system.

The second research was connected with united informational space, forming nowadays, and effects on the administration process, its communication and informational components. This united informational space is based on computer and network engineering. Administrative efficiency depends on creating favorable conditions for consolidation of information resources. Territorial planning is made by establishing zones of an object planned placing, they are so called Investment sites. Territorial planning schemes are based on social-economical development Strategy, and define the lines of the territory development, that is why goal-oriented programs and plans of settlements and territory infrastructure are elaborated on the basis of these schemes, and the so called Investment sites plans are also elaborated on the basis of these programs. Success of the whole Region territory development project depends on the efficiency of investment sites placing administration – the lowest stage of territory planning.

The third methodology was created by applying the optimal variant of using city territories for the educational institution location by choosing the best combination of variables (estimation factors) at the maximum of the estimation function. The electronic card was developed in the ArcView 9.2 ESRI environment taking into consideration ecological and geological aspects of the particular area, available infrastructure level, engineering services, cultural and welfare facilities, downtown accessibility, main urban service facilities, historic, landscape and recreational value of the city area.

Keywords: GIS, territorial planning, investment sites, institution location, functional use, modelling

1 Information model of territorial development process management

1.1 *Information System*

Territorial development is determined as progressive change of spatial structure of people's economy parts for creation of optimal human environment. It is also determined as economic-geographical process of formation and qualitative transformation of regional economic systems. Besides, two more aspects of territorial development are singled out: obtaining potential and transformation of resources. As a result, territorial development is determined as “the activity on realization (self-realization) of the district's potential; as per material it represents resources transformation, its mechanism is self-organization, as a result-complication of the structure, which is revealed in the growth of variety and coordination of the elements of regional systems.

The process of territories management, its communicative and information components, is being more influenced by formation common cyberspace, which is being based on computer and network technologies.

The efficiency of management depends greatly on creation of the conditions for consolidation of information resources. The target function of the creation of information resources is the provision of state identification: social-economic, public-political and scientific-technical processes and phenomena, and also potential possibility of elaboration on its basis of the recommendations on decision taking.

Information-analytical systems correspond to interconnecting of the whole raw of information technologies: collection and transference of information, search and keeping of data, their representation for the user.

In the aims of management and control of processes of territorial implementation and development Information-analytical management system of territorial development process is being elaborated. The system consists of two interconnected blocks: Information base of investment projects and simulation model of territorial development (Figure 1).

1.2 *Simulation model*

Simulation model is logic-mathematical description of management processes of territorial development on basis of amalgamation of formal and informal methods, taking into account of determined and probability factors.

Modeling of processes of territorial development is performed via system of subject strata, imitating real processes, and factors, and having compulsory spatial matching; and also analytical procedures and methods, describing interaction of primary data, and expressing the result of their mutual influence.

Within the framework of simulated modeling complex evaluation of territory is being effected, then on its basis the evaluation of potentials of the region and calculation of priority of kinds of functional use of the territory is being carried out. The latter calculates, what kinds of functional use will be mostly rational and useful for those and other territories, what finally will determine priority trends of development of separate territories.

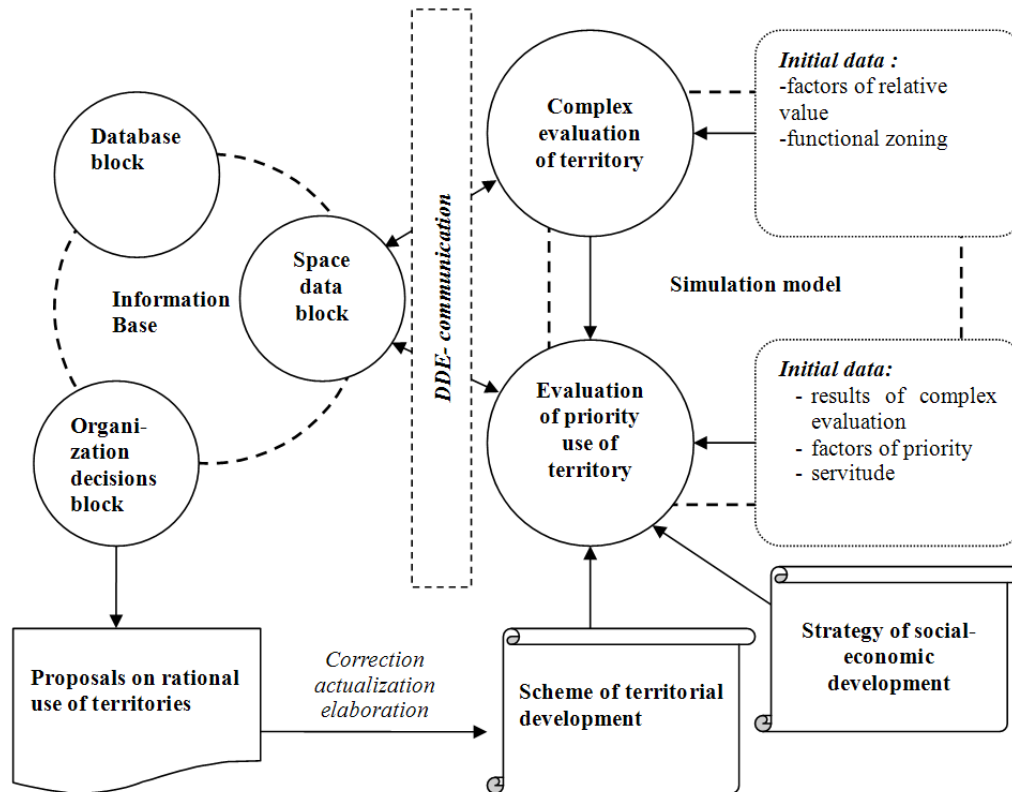


Figure 1, Structure of Information-analytical management system of territorial development process

The selection of priority trends of territories development is conducted from the list of kinds of functional use, including the following groups:

- agriculture,
- use of territory for settlements,
- industry, transport etc.,
- specially protected territories (recreation),
- forestry,
- water management.

The selection is conducted as per maximum indication of target function of the priority of territory use, which is calculated separately for each corresponding kind of functional use of territory as per the Eq.1.

$$F(x,y)=x_1y_1^i + x_2y_2^i + \dots + x_ny_n^i \quad (1)$$

Where x_n - is the expression of n-factor of relative value of the territory, y_n^i - coefficient of priority of n-factor of relative value of territory for i-kind of functional use of territory.

On each kind of functional use of territory the imitation model is being developed, with which you may determine the most attractive districts for corresponding kind of functional use of territory.

GIS is the main instrumental basis for elaboration and functioning of the territory development imitational model. Present day GIS include almost all the necessary modeling instruments. They are: presentation of data as thematic layers, geometry modeling functions, competent mathematic apparatus, data base management system and also wired programming language helping to create and carry out the procedures that don't exist among GIS instruments.

1.3 Evaluation of recreation areas

For developing simulation model of Rostov region, realizing the evaluation of recreation usefulness of territory, the following actions were fulfilled:

- parameters of evaluation of recreation areas are singled out;
- classification of recreation areas as per specialization is carried out;
- electronic card of priority areas is developed;
- classification of organization-technological arrangements on liquidation of negative influence of the environment and the increase of recreation of territory attractiveness has been elaborated;
- program module, realizing modeling of the above mentioned organization-technological arrangements has been elaborated.

Parameters of evaluation of recreation areas consist of Main factors and Additional factors. Main factors are: duration of favorable temperature conditions, availability of sea coast, relief character, availability of forests, rivers, lakes and water reservoirs, state of environment, transport highways provision. Additional factors are: availability of outcrops of water, availability of balneological resources, characteristics of beaches, sightseeing objects of natural character.

Classification of recreation areas is based on parameters of evaluation of recreation areas and represented by following categories: Tourist-health-improving-hunting-fishing areas, Health-resort-tourist-health-improving areas, Health-resort areas, Tourist-health-improving areas, Hunting-fishing areas (Figure 2).

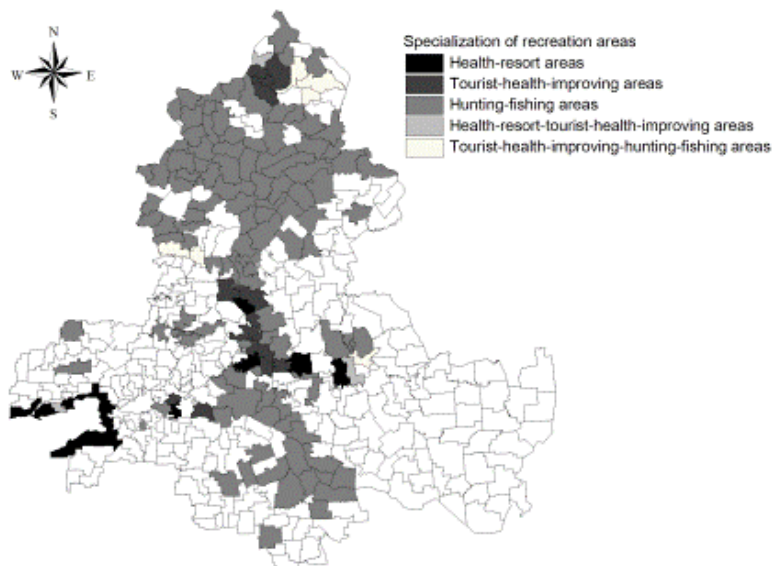


Figure 2, Territories of Rostov region on degree of convenience of placing of recreational areas

Classification of organization-technological arrangements on elimination of negative influence of the environment and the increase of recreation of territory attractiveness are divided into groups of Measures on improving ecological situation: Reduction of industrial load, Reduction of transport load, Reduction of pollution of atmospheric air, Reduction of pollution of drinking water, Reduction of soil contamination and agricultural produce, Improvement of the health condition of the population.

1.4 Program module

Program module “Modelling of recreation complexes” realizes modelling of the processes of conducting of organizational-technological arrangements on the increase of recreation attractiveness of the territories using GIS -technologies.

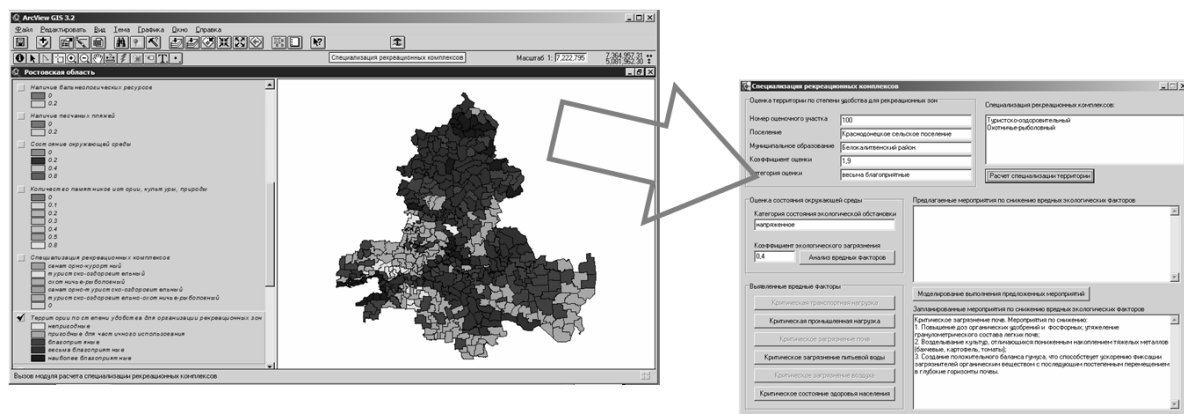


Figure 3, Program module “Modelling of recreation complexes”

The process of modelling the arrangements, with consequent removal of the 1, 2, 3, 4 contaminating factors is shown at the Figure 4.

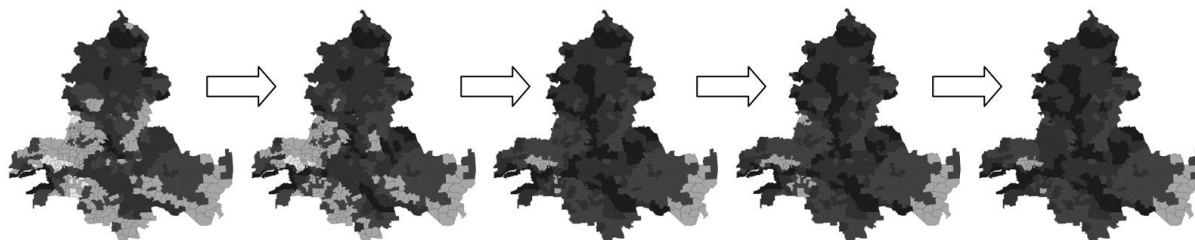


Figure 4, Territories on degree of convenience of placing of recreational areas. Consequent removal of the 1, 2, 3, 4 contaminating factors

By generating such models in respect to other types of development, combining and comparing them, one may obtain scientifically grounded strategy of development of the district for long-term outlook. Use of information systems allows to make this strategy constantly renewed, and the process of territorial planning – continuous one.

2 GIS and territorial planning

At present moment territorial planning, as a project activity, is at the stage of instrumental basis planning and the system of project planning control. The change-over from using the paper maps and manual methods of working with geographic data to using newest computer technologies is taking place. Modern information systems development gives the basis to the progress of new planning methods of territory development. The instruments of large statistic volume processing and instruments of imitation modeling became accessible.

Territorial planning has a clear-out geographical essence, which is why the Geographical Information Systems (GIS) are used as the project basis for this activity.

We suggest using the GIS as means of data storage and retrieval, instrument of data analysis and Russian Federation subject development modeling, and as the basis for project schemes (focused on optimizing of territory use) development, making the basis for its constant development.

The program of the Rostov region Territorial development is connected with singling out on the territory of region zones, called Investment areas, of intensive developing on the territory of region.

These Investment areas are subdivided according to their intended purpose: housing, recreational, sociocultural, industrial etc.

Location of such areas on the territory should be scientifically grounded, satisfy the strategically plans of the region development, and satisfy the population needs.

The following operations were made for the Rostov region territory analysis in the ArcGIS 9.2 medium:

- the analysis of the basic potentials: town-planning, agricultural, manufacturing;
- the basic Investment areas of Rostov Region were plotted on the electronic map;
- Investment areas database, including the investment area passport and it's topographical plan are worked out;
- the algorithm of optimizing the investment sides distribution is also worked out.

Notation conventions: Investment areas

- cottage buildings
- construction engineering buildings
- complex buildings
- sociocultural zone
- industrial-storage zone
- industrial buildings
- agricultural recycling zone
- semifunctional complexes
- no ideas for using

The major part of the Investment areas is based in the most intensively developing part of Rostov region – Rostov agglomeration. This concentration is provided by the proximity to the regional center – the most populated part of region. But the analysis of the density of population chart showed that there are two densely populated areas in Rostov region: East-Donbas agglomeration – in the West part of region, and Volgodonsk settlement system – in the East

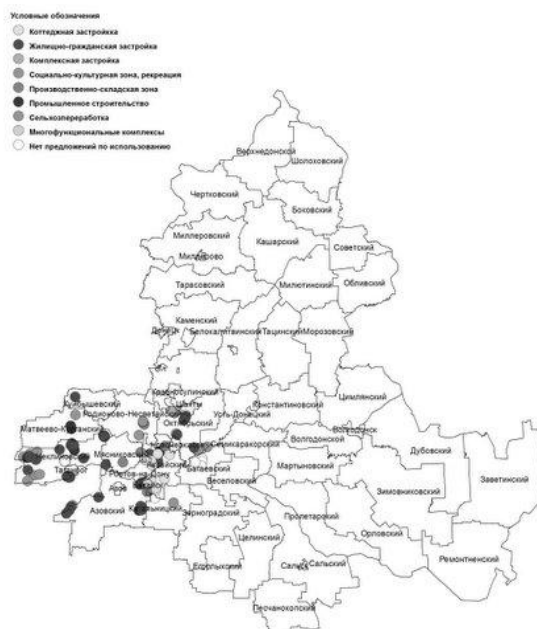


Figure 5, The stated Investment areas on the Rostov region territory

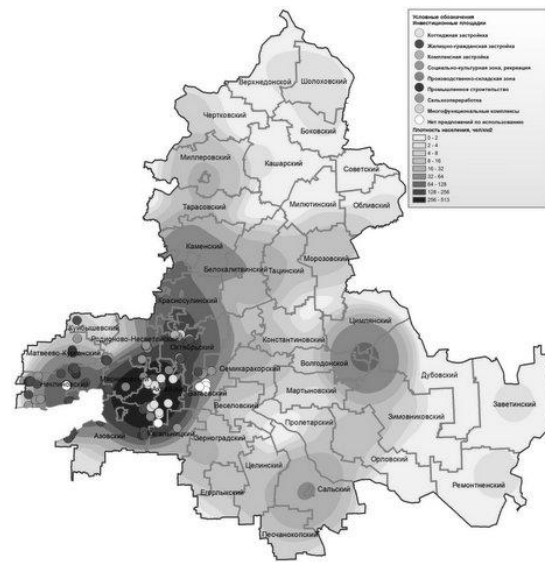


Figure 6, Rostov region density of population

Notation conventions: Investment areas

- cottage buildings
- construction engineering buildings
- complex buildings
- sociocultural zone
- industrial-storage zone
- industrial buildings
- agricultural recycling zone
- semifunctional complexes
- no ideas for using
- Population density, persons per sq.km

Territorial development should be complex and balanced, that is why the Investment areas location should satisfy economic, labour and industrial resources distribution. Strategic plan of the region socioeconomic development includes detailed analysis of these factors that is why the Investment areas location should meet this plan. The GIS use gives an opportunity to make a complex graphic analysis of the territory according the positions of the Russian Federation constituent territory socioeconomic development.

The basic potential Regional development analysis showed the presence of Investment areas in regions with low potential development. East-Donbas agglomeration and Volgodonsk settlement system, mentioned above, have the territories with high potential rates: town planning, agricultural, industrial. Consequently, these territories should be included into the intensive development program.

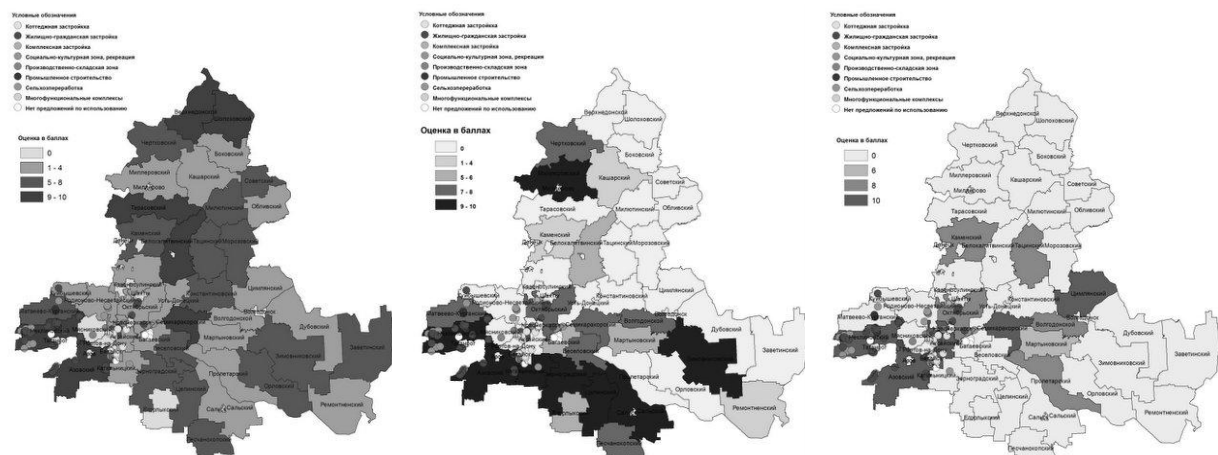


Figure 7, Analysis of potentials: a- town planning potential, b- agricultural potential, c- industrial potential

The algorithm contemplates the carrying out of the Investment areas distribution analysis and its conforming the scheme of territorial development planning and the strategical plan of Russian Federation (RF) socioeconomic development, approved by law. The next stage is its meeting the projecting norms control. GIS-technologies is the indispensable instrument for all types of analysis carrying out and for information visualizing.

As a result the algorithm gives an opportunity to plan the project proposals concerning the optimal Investment areas distribution on the territory of RF constituent territory.

The algorithm put forward was realized for the Investment areas group disposition in the South of Rostov Region analysis. The analysis showed that some investment sides do not pass the sanitary project standards, because they are situated on the territory of sanitary zone of Rostov-Baku federal line. Recommendations concerning the transferring of two Investment areas to another place were given.

The similar analysis the other areas showed, that the considerable part of the investments planned to be made into the Region go to the regions with low potential, so it is necessary to formulate a policy of the investments mobilization to the regions with high potential correctly. It is important to increase the quantity of the investment flows and refocus the present capital investments to the most favorable and developed regions.

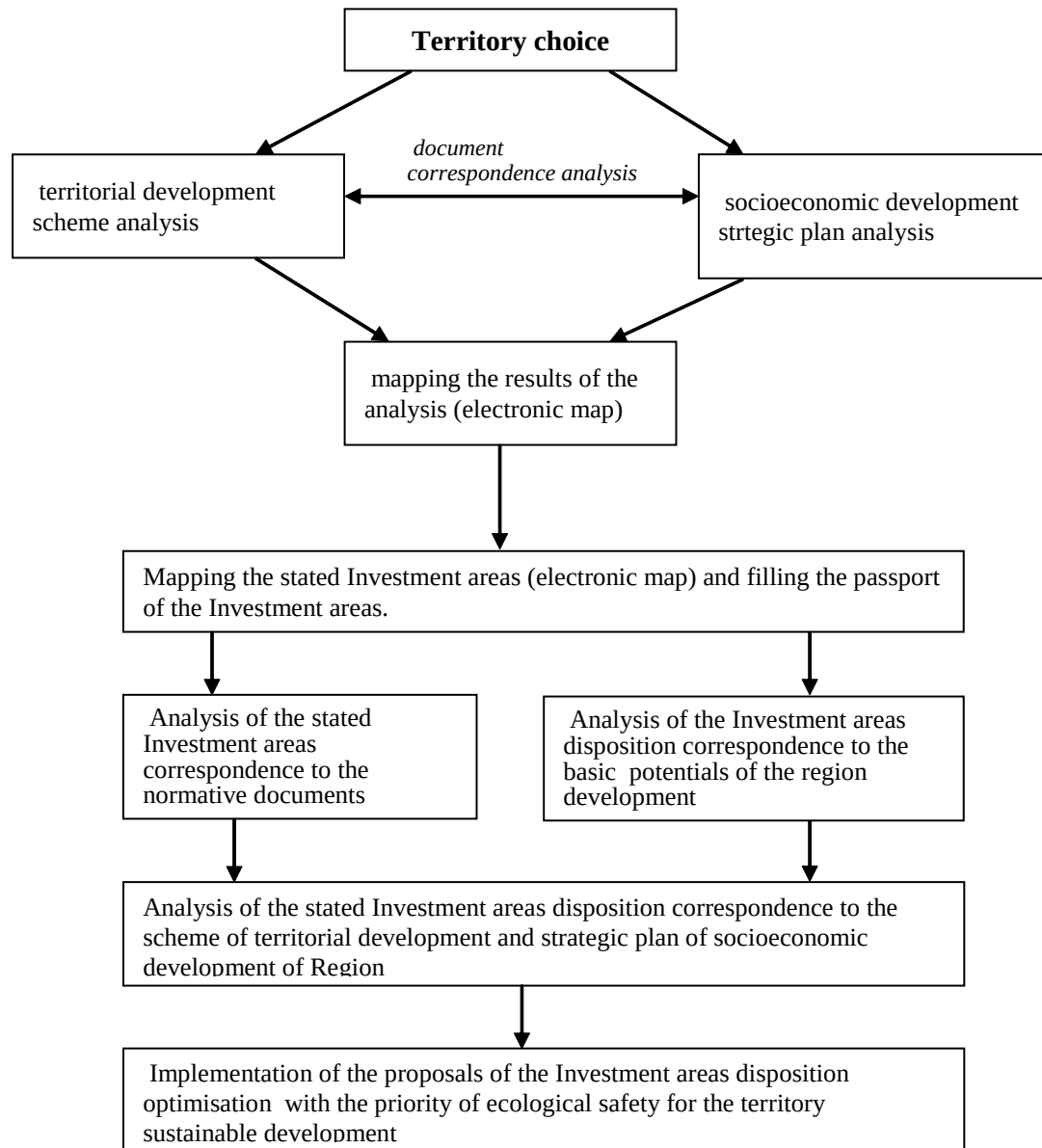


Figure 8, Investment areas disposition optimizing analysis

3 The methodology of strategic management of the educational institution location on the urban territories using the GIS – technologies

One of the most topical problems of the educational space planning is the efficient distribution of the new educational objects providing various educational services taking into account the requirements of possible school enrolment, urban transport and communications expansion, other socio-economic,

natural and geographical factors. To solve this problem we need to use new technologies for more operational territorial distribution planning of educational space objects and data retrieval of the existing educational systems operating.

Worked out methodology of objects distribution on the basis of the General City Plan taking into account the city density of population of the necessary quantity of free education and also facilitating the full valued infrastructural development of educational objects in city, high-quality system of mass public upbringing and educational organization, which provides the population intellectual potential growing and the educational process and standards perfecting, outfitting the educational objects accounting the new programs demands can solve this problem.

At the Urban planning and Community development department of the Rostov State University of Civil Engineering specialists developed methodology of the city reconstruction sites estimation to distribute educational objects using GIS-technologies.

While defining the most optimal variant of using city territories in a process of the planned reconstruction we are faced with the aim of choosing the estimation criteria of these territories from the point of view of educational objects distribution. The description of each aim includes the components (factors) solution and the system of aims description. In our case we deal with the classic optimizational aim of choosing the best combination of variables (estimation factors) at the maximum of the estimation function. For solving this problem we were carrying out some interconnected actions, which are:

1. Separation of the city territory into sites.
2. Developing the list of estimation factors, general for all the sites.
3. Choosing and giving the desirability coefficient of estimation factors.
4. Calculation of each estimation factor coefficient.
5. Calculation of the mentioned site summary rating.
6. Choosing one of the sites according the maximal meaning of the estimation factor summary rating.

Mathematics expression of the estimation function was developed in according with principles of systems engineering (See Eq.2)

$$f(x) = A_1 + A_2 + A_3 + \dots + A_n = \sum_{i=1}^n A_i, \quad (2)$$

Where, A_i – is a rating estimation, depending on variable factors.

Figure 9 illustrates the block diagram of choosing the best variant of the most effective functional sites using algorithm.

In the capacity of the criteria factors for estimation of the city sites we take the list of the relative value factors of the territory. These factors are united into 8 groups. They take into account the characteristics of the reconstructed sites:

1. Population accessibility to the city center, objects of culture, general services
2. Provision of central installation and territory equipping with services and utilities.
3. The level of population community services progress
4. Historical, esthetics and landscape value of the urban territories
5. The environment, sanitary and microclimate condition
6. Geologic conditions of territories and degree of the territories liability to the environment destructive effects
7. Territories recreation value
8. The city density of population

Each of the factors group has a big quantity of different information. That is why they are subdivided into the number of individual subfactors.

Subject to the range of the integral rating estimation the urban territories are colored on maps into particular colors tints of different intensities (e.g. Figure 10). This methodology of efficient planning and the distribution of educational space objects became possible thanks to using the GIS – technologies. They give an opportunity to make the analysis of the educational objects data discovered earlier (e.g. Figure 11, 12), density and structure of population and its distribution on the territory of the city. General City Plan projects including plan of modern territory using, new housing distribution scheme, the basic directions of city-planning service center systems development, the rules of land use and building (e.g. Figure 13), geological (e.g. Figure 14) and ecological (e.g. Figure 15) schemes are also analyzed.

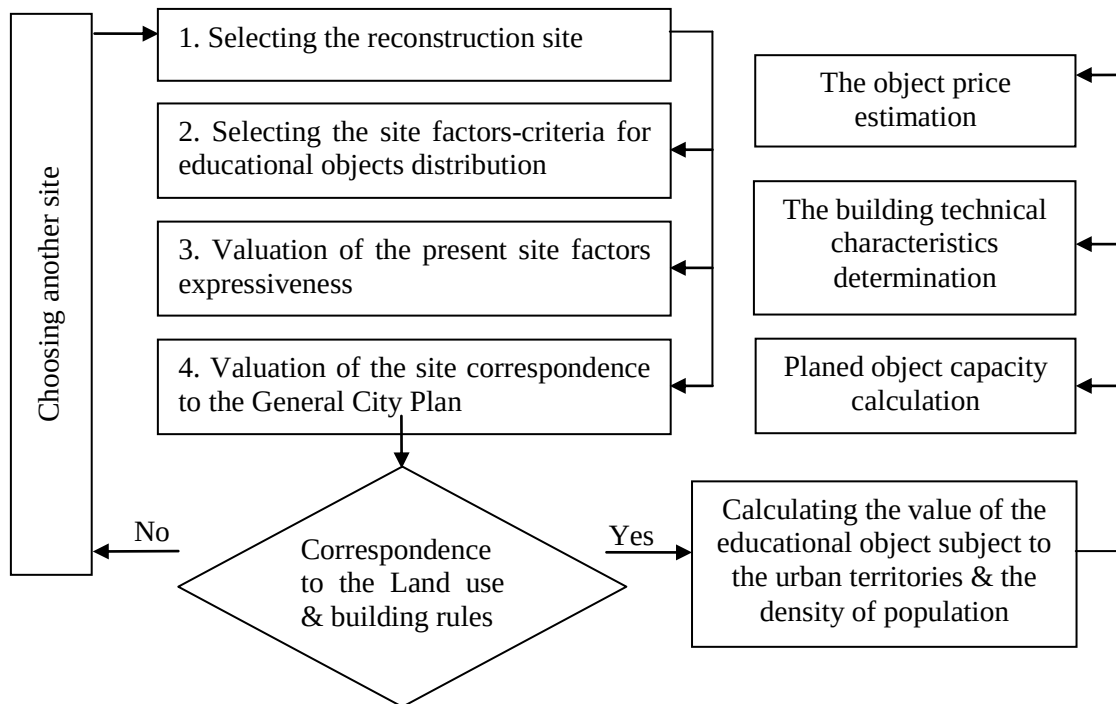


Figure 9, The block diagram of choosing the best variant of the most effective functional sites using algorithm

With the help of program complex ArcGIS 9.2 by setting the desirability coefficients of the estimation factors, we got the electronic maps of optimal using the urban territories of different types and functional using.

The methodology also helps to determine the demand in new building and reconstructing the existing educational complex objects in the city and gives an opportunity to optimize the use of the territory for different city functions on the basis of the present day educational objects plight and tendencies definition and the basic directions of long term educational objects system development to reach the standards.

This methodology is realized with the help of ArcGIS 9.2 on the example of Rostov-on-Don. Developed methodology allows to make situational (operational) decisions for implementing the strategic approach to the management of educational objects setting, for the management of the reconstruction of urban territories and supports innovative accompaniment of the process of development and implementation of priority national projects, targeted programs of ecological reconstruction and strategic plans of socio-economic development of municipalities.

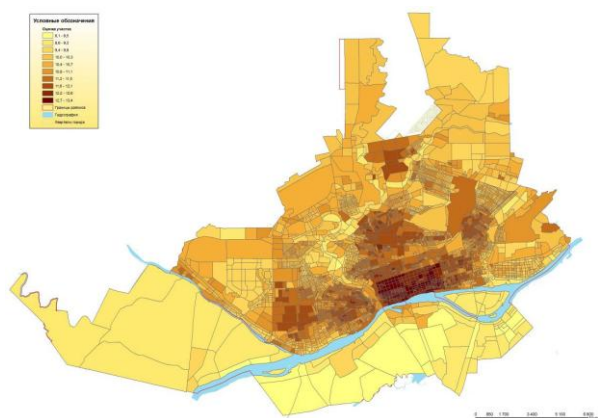


Figure 10, The map of integral rating estimation the urban territories of the educational object provision

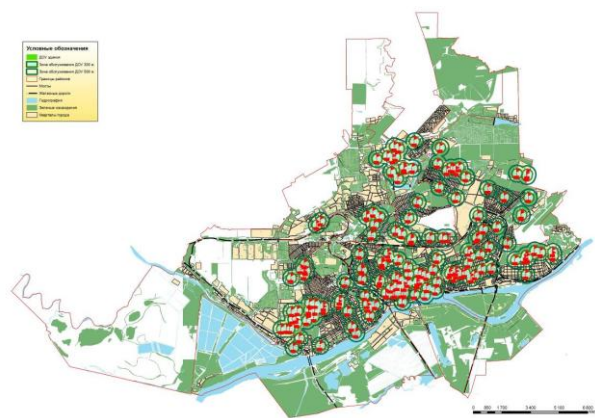


Figure 11, The analysis of the present preschool educational objects distribution map

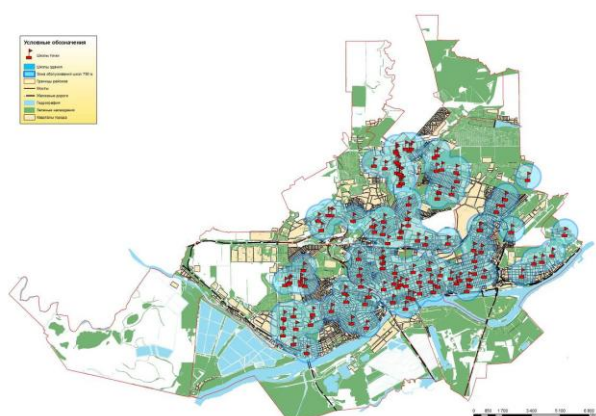


Figure 12, The analysis of the present school educational objects distribution map

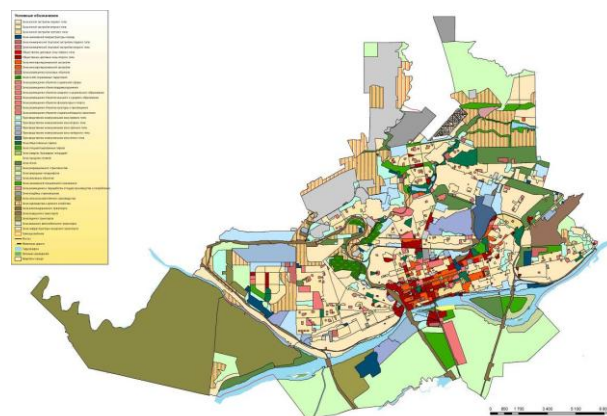


Figure 13, The rules of land use and building map

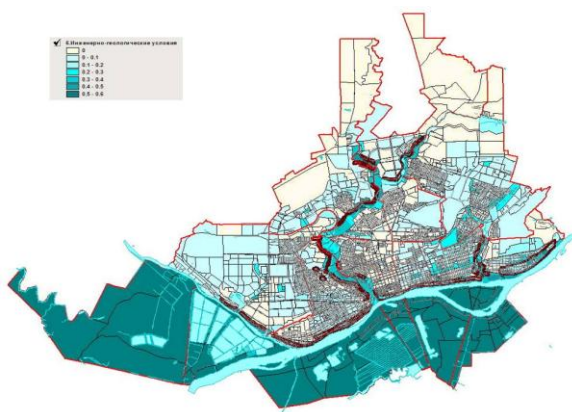


Figure 14, The map of integral rating geological conditions estimation the urban territories

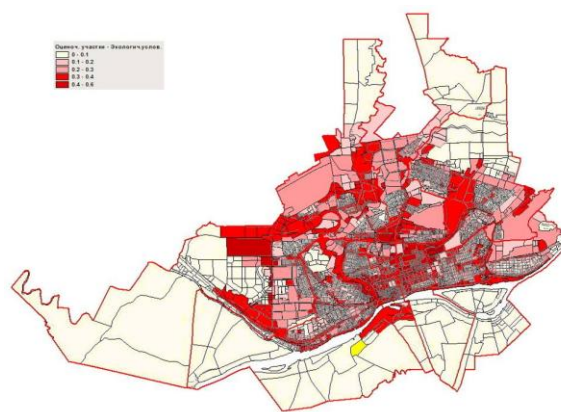


Figure 15, The map of integral rating ecological conditions estimation the urban territories

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