UDC 711.25

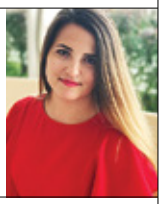
Sheina S.G.
Fedorovskaya A.A.

Methodology for improving the agricultural suitability of land for the sustainable development of a territory

The concept of long-term socio-economic development of the Russian Federation predetermines the sustainable development of rural areas, as well as an increase in the standard of living among the rural population. These processes can be optimized within the framework of a competent urban planning policy by a geographic information system. Geoinformation systems ensure the sustainable development of a territory by using simulation tools to plan a set of environmental measures, as well as the measures to improve the agricultural suitability of lands. The article describes the data integration process towards the comprehensive assessment of the territory of the Rostov region, describes the research methodology, and identifies the key factors that are behind the indicators of agricultural suitability of land. The authors present the preparatory stage, or data collection for a simulation model. The justification of development planning solutions for rural areas is provided as a detailed classification of lands and anthropogenic factors that affect the stability of the entire landscape system of a constituent entity of the Russian Federation. The method of an objective function and the use of the priority matrix is used to calculate the agricultural suitability of the territory. A set of environmental measures has been developed on the basis of the levels and types of damage and pollution of the territory of a constituent entity of the Russian Federation. The proposed set of measures is standard, although it includes an assessment of their effectiveness. The result of the study is presented in the form of the maps of the Rostov region, demonstrating the agricultural suitability of the territory for the crop production before and after the corrective measures. The conclusion discusses the prospects for the application of the simulation model, its versatility and advantages.

Keywords: *sustainable development, rural settlements, simulation modeling, environmental sustainability, land suitability, agro-industrial complex, peripheral zones, territorial planning*

Sheina Svetlana Georgievna,
PhD in Engineering, Professor, Counselor RAACS, Assoc. Prof. of the Dept. of Urban engineering and facilities; Don State Technical University (DSTU); 1 Gagarin Sq., Rostov-on-Don, 344000, Russian Federation; ID RISC: 510975, Scopus: 55988259100, ResearcherID: I-3976-2014, ORCID: 0000-0001-5214-0767; rgsu-gsh@mail.ru



Fedorovskaya Albina Ahmedovna,
Candidate of Technical Sciences, lecturer of the Departments of Urban Engineering and Facilities; Don State Technical University (DSTU); 1 Gagarin Sq., Rostov-on-Don, 344000, Russian Federation; ID RISC: 679259, Scopus: 57194454315, ORCID: 0000-0002-6096-5889; bina-87@mail.ru

Territorial development of rural settlements has long been based on a systematic approach. Theoretically, rural areas are studied using the geographical approach in conjunction with the assessment of socio-economic, environmental, and labour potentials. The Strategy for the sustainable development of rural areas of the Russian Federation (hereinafter — RF) for the period up to 2030[1] defines the sustainable development of rural areas, which includes the following list of simultaneous processes:

- an increase in the productivity of the agro-industrial complex (hereinafter — AIC) and the efficiency of agriculture;
- steady socio-economic development of territories;
- maintaining welfare, that is, ensuring the full employment of the rural population that will bridge the gap between the rural and urban population (up to 85 %);
- improvement of the level and quality of life among the rural population;
- rational use of natural resources [1].

The experience of various countries should be addressed to present the global development of rural settlements. The results of the analysis are provided below (see Fig. 1).

We should also mention the key foci of the EU policy that coincide with the development goals of rural settlements in the Russian Federation.

1. Sustainable rural development and environmental management, supporting the transition to climate-resilient agricultural production, forestry, and low-carbon food processing.

2. Innovative development of the agro-industrial complex and promotion of retention of labour and intellectual potential in the agro-industrial complex, forestry and rural areas in general.

3. Promotion of social inclusion, poverty reduction, and economic development of rural areas, the priority of preserving rural population.

4. Reproduction and more efficient use of land and other natural resources, environment-friendly initiatives in production [1].

The case study of rural development employs the following tools:

- geographic information systems and databases of agricultural land monitoring (EFIS ZSN as the information system on agricultural land) [3];
- databases on the status of parameters of socio-economic conditions in the RF subject, created in the ArcGIS ESRI environment (hereinafter — ArcGIS ESRI environment DB) developed in specific conditions and annually updated on the basis of the data provided by the Russian Federal State Statistics Service (Rosstat);
- data obtained as a result of the environmental monitoring of the territory of the subject of

1 Strategy for the sustainable development of rural territories of the Russian Federation for the period up to 2030 : approved by the Government of the Russian Federation on February 2, 2015. No. 151-p. URL: http://www.consultant.ru/document/cons_doc_LAW_174933/2844094b7ba6e57e91fd5bb036ee91d9f6727238 (Accessed: May 10, 2022).

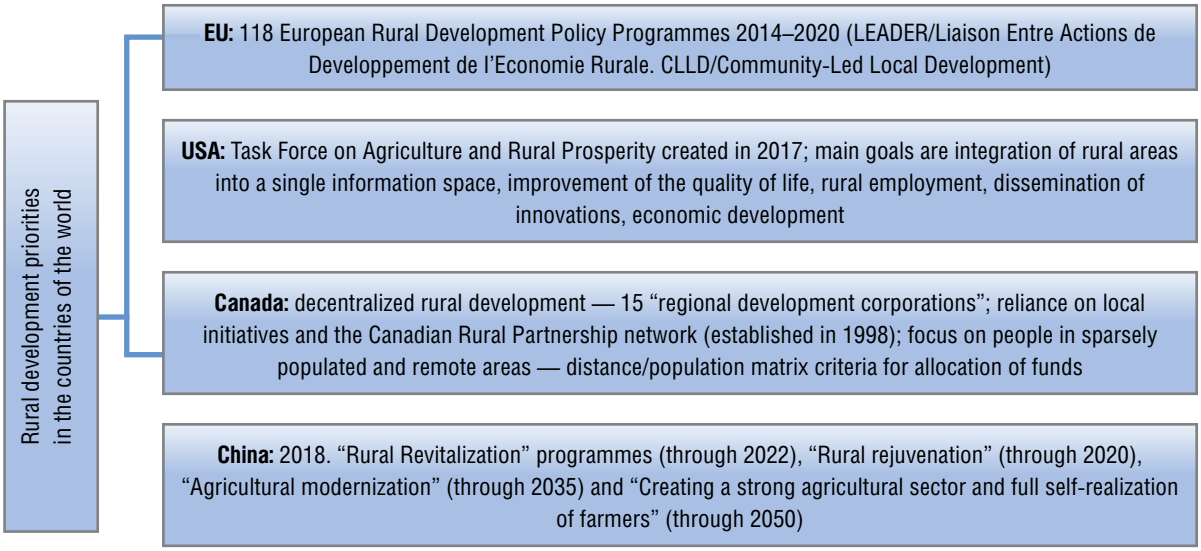


*Fig. 1. Priority areas of rural development: the global experience [2]. The left vertical line: Priority areas of rural development worldwide; the top horizontal line: **EU:** 118 programmes of rural development in Europe for 2014–2022 (LEADER/Liaison Entre Actions de Dévelopement de l'Économie rurale, CLLD/Community-Led Local Development); the middle horizontal line: **Canada:** decentralized development of rural territories — 15 regional development corporations; support through local incentives and Canadian Rural Partnership (est. 1998); principal attention is focused on the dwellers of remote and scarcely populated areas, a matrix criterion for the distribution of funds being the "distance/population density"; the bottom horizontal line: **China:** 2018 — Countryside Revival programme (through 2022), Countryside Rejuvenation programme (through 2020), Agricultural Modernization programme (through 2035), and Strong Agricultural Sector Creation and Self-Fulfillment for Farmers programme (through 2050)*

Russian Federation integrated into the database in the ArcGIS ESRI environment DB;

- the land use layout for the RF subject integrated into the ArcGIS ESRI environment DB;
- information and simulation modeling, development and changes in the rural areas of the subject of Russian Federation.

The processes involving environment-friendly initiatives in production, decision-making optimization in urban planning policy, and monitoring of land are closely linked and require the development of a simulation model to improve the agricultural land usability [4]. The preparatory stage of designing a simulation model needed to improve the agricultural land suitability includes the steps shown in Fig. 2.

Hence, rural areas should be analyzed using the system of comprehensive assessment [5].

The implementation of all of the above steps allows to develop a simulation model to improve the agricultural land suitability (see Fig. 3).

Cartographic methods of visualization, applied to development processes and analysis of territories on the basis of GIS technologies, are an effective tool used by various target groups of specialists in the field of urban planning and regional management. The implementation and demonstration of the results of a comprehensive assessment of the territory in the ArcGIS ESRI environment allows to optimize the decision-making process by systematizing all incoming information and land monitoring data.

It is necessary to identify the main branches of agriculture and the degree of influence of the agricultural priority of land on their development following the comprehensive assessment of the territory of the RF subject. The key sectoral specializations of the agro-industrial complex are:

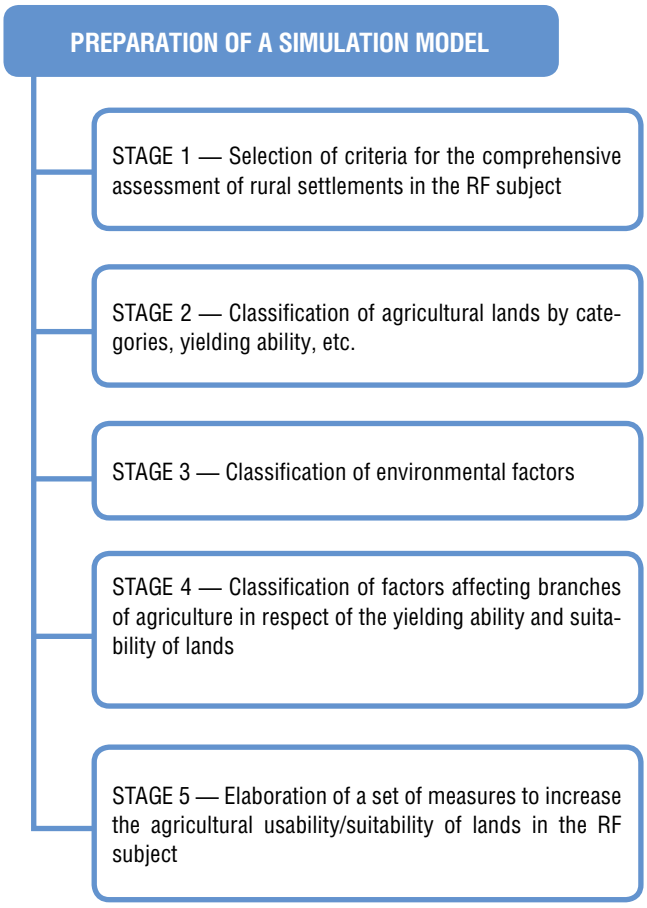


Fig. 2. Preparation of a simulation model

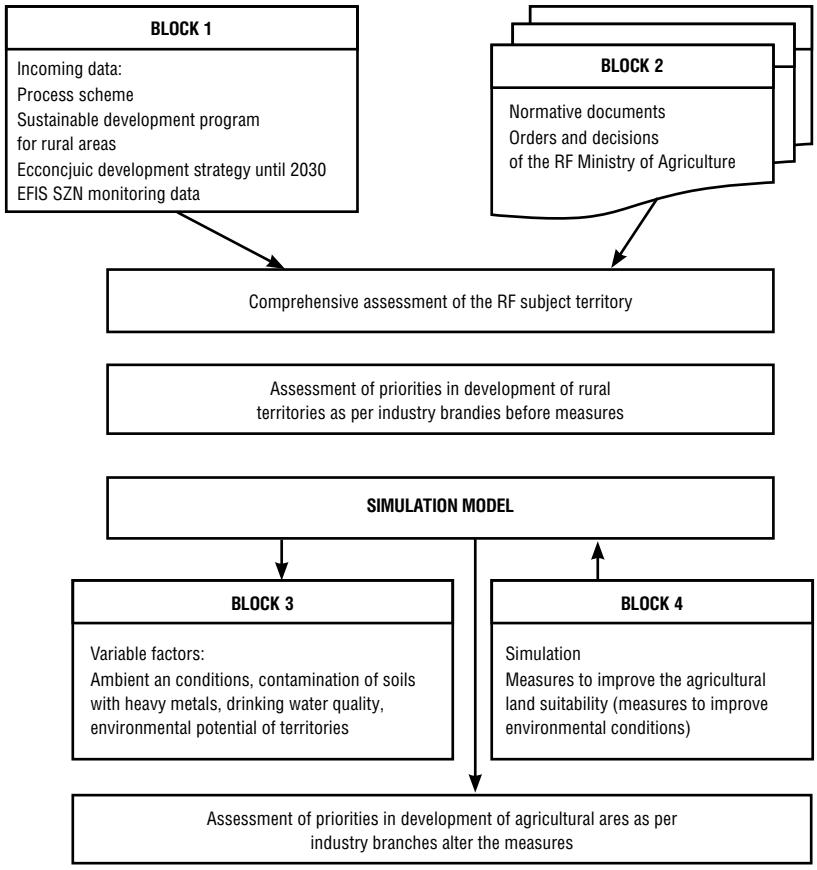


Fig. 3. Simulation of the agricultural land suitability enhancement in the RF subject

- animal breeding;
- crop farming;
- agricultural produce processing (enterprises and manufacturing facilities);
- machine building.

Therefore, crop farming and, indirectly, animal breeding have the greatest influence on the specialization and the agro-industrial complex of the territory. This means that it is reasonable to use the case of crop production and improvement of the agricultural land suitability in the subject of the Russian Federation to demonstrate the operation of the model under consideration and its implementation. Here we use the case of the Rostov Region, one of the leading agrarian regions in the country.

First of all, all stages of preparation for the simulation process are performed (see Fig. 2). The process of preparation is shown stagewise.

Stage 1. Selection of criteria for the comprehensive development assessment of rural settlements in an RF subject.

For this purpose, the factors, presented in Table 1 below, are employed to conduct a comprehensive assessment of the territory.

F7. The integral indicator of natural factors. The integral assessment of an area using natural factors encompasses two indicators: the ecological potential of natural landscapes and the sustainability of ecosystems.

F8. The integral indicator of the anthropogenic load is determined by summing up the impact on the natural and man-made environment (transport, production, agriculture, etc.).

Table 1. Comprehensive assessment factors

Identification	Factor	Numeric value, points
F1	Crop farming branches	0…1
F2	Animal breeding branches	0…1
F3	Agro-climatic resources	0…1
F4	Ploughland yielding capacity	0…1
F5	Agricultural stress	0…1
F6	Degradation of soils	0…1
F7	Integral indicator of natural factors	0…1
F8	Integral indicator of the anthropogenic load	0…1
F9	Atmosphere air pollution	0…1
F10	Pollution pf soils with heavy metals	0…1
F11	Drinking water quality	0…1
F12	Environmental potential	0…1

F12. The environmental potential includes the following parameters:

- air temperature;
- relative humidity;
- condensation processes in the atmosphere;
- heat supply.

Factors F9 to F12 are variable; when included in the simulation model, they allow to clearly demonstrate changes in the suitability of agricultural land. Each factor is scored from 0 to 1. The results of the comprehensive assessment of a territory are the basis for determining the agricultural (hereinafter — A/C) priority of territories.

Stage 2. Classification of agricultural lands (broken down into categories on the basis of the yielding capacity).

According to Article 22 of the Land Code, agricultural lands are the lands for the agricultural production, agricultural research and training activities, accommodation of the corresponding production infrastructure, or designated for these purposes (Table 2)[2] [7].

Stage 3. Classification of environmental factors.

The main pollution factors affecting the environment in the Rostov Region are:

- condition of the atmosphere air;
- pollution of soils with heavy metals;
- quality of drinking water.

Stage 4. Classification of factors affecting the branches of agriculture in terms of the productivity of land, its suitability for agricultural use.

The main factors of anthropogenic impact on soils are (Table 3):

- salinification;
- erosion;
- desertification;
- pollution, land disturbance during construction;
- mining;
- storage of wastes;

Table 2. Classification of A/C lands on the basis of the yielding capacity [6]

Group	Land type
Productive lands	Ploughlands
	Hay-making lands, including natural ones, improved, seeded with crop rotations of perennial grasses
	Pastures
	Fallow lands, which are not inarable, and other lands unsuitable for agricultural production
	Land occupied by perennial plantings (orchards, vineyards, etc.)
	Lands enclosed by water bodies used for the production of marketable products
	Land occupied by forests and shrub vegetation, which can be used to obtain marketable products
Non-productive lands	Land occupied by farm roads
	Land occupied by utilities, as well as linear and other structures not related to the agricultural production
	Lands occupied by trees and shrub vegetation intended to protect lands from the impact of negative (harmful) natural, anthropogenic and technogenic phenomena, protective forest belts
	Land occupied by enclosed bodies of water not used in the manufacturing of commercial products
	Fallow lands, which are inarable and other lands unsuitable for agricultural production
Lands occupied by buildings and structures	Land occupied by buildings, structures and facilities used for production, storage and primary processing of agricultural products
	Land occupied by other structures used in the process of agricultural production (sheds, drinkers, structures of reclamation systems, warehouses of solid mineral fertilizers, meliorative agents, etc.)

Table 3. Anthropogenic factors divided into groups

Group	Type of land	Description
Main factors	Soils, topography, water bodies, buildings, plants, animals, etc.	Static
Process factors	Plowing of soil, corrosion of metals, moving plants and animals, etc.	Dynamic
Phenomena	Air, water, soil pollution, radio waves, electric current, etc.	Variable

2 The Russian Federation Land Code dd. October 25, 2001 No. 136-FZ (ver. dd. December 25, 2018) (with consequent amendments and additions, valid as of January 01, 2019) : The RF Official Gazette. 2001; Oct. 29(44):4147.

• alienation of land for the purposes of industrial and municipal construction [7, 8].

Stage 5. Elaboration of a set of measures to improve the suitability of land for agricultural uses in the subject of the Russian Federation.

A set of environmental measures were developed and presented in Table 4 to improve the agricultural suitability of areas, which are rated as low priority ones as a result of assessment.

The result of a set of measures in the low rating areas is a rise in the indicators and, consequently, a higher priority rating of the territory for agricultural development (Table 4). This process is a simulation of an increase in the agricultural priority of the territory, and the measures are presented according to the above stated environmental factors with an assessment of their efficiency[3, 4, 5] [9, 10].

After a comprehensive assessment of the territory of the Rostov region, the calculation of the agricultural specialization priority is made in respect of the crop production.

By compiling a matrix of the agricultural priority, significance coefficients are determined for each F1–F12 factor in respect of crop production, and then the calculation is made.

For this purpose, importance coefficients are determined (varying from 0 to 1) for each factor and entered into Table 5. It should be noted that the survey was conducted among a group of 5 experts with the help of the questionnaires developed for this particular task.

The A/C priority rating is calculated using the target function formula (1), by multiplying the matrix by the results of a comprehensive assessment.

$$P^j = \Sigma Q_i \cdot R_i^j, \quad (1)$$

where P is the value indicator (utilization priority) for j-th type of A/C specialization; Q is i-th relative value ratio of the territory; R is the importance coefficient of the i-th factor for j-th type of A/C specialization.

The result of the calculation is a priority map of agricultural specialization, or crop production, implemented in ArcGIS ESRI (Fig. 4, *a*).

A set of environmental measures is needed to increase the arable land's suitability in the areas featuring low priority ratings. The simulation model is implemented and the recalculation of the P indicator is made anew as a result of environmental measures[6] [11, 12].

After the implementation of a set of environmental measures and the recalculation of the rating of agricultural priority lands, the land use map, showing the crop production, looks like the one shown in Fig. 4, *b*.

The comprehensive land assessment and agricultural priority maps of the Rostov region, demonstrating the soil fitness for the crop production, the priority districts are: Egorlyksky, Tsimlyansky, Zernogradsky, Kagalnitsky, and Myasnikovsky. After the implementation of a set of environmental measures and the recalculation of the rating, the list is supplemented by the following districts: Sholokhovsky, Verkhnedonsky, Kasharsky, Salsky, Proletarsky, Tselinsky, Zimovnikovsky. Hence, the analysis of the maps shows that the suitability of land grows not only in the south-west of the region, but also in its southern and northern parts. Using such a parameter as the agricultural suitability of the territory, geographic information systems can clearly demonstrate future changes to be caused by the reduction in the anthropogenic load and implementation of environmental protection measures.

The proposed simulation model is universal and can be applied to the territory of any subject of the Russian Federation in the current conditions of natural and man-made environment and landscapes [13–15]. This model can find the most suitable sites and territories for AIC enterprises and the arrangement of

Table 4. Results of implementation of a set of environmental measures

Factor	Measures
Air pollution	Creation of sanitary protection zones, sewage treatment plants, introduction of lower emissivity technologies, treatment of emissions
Soil pollution	Development of systems for the recycling of industrial waste into secondary material resources; replacement of toxic waste with non-toxic waste; replacement of unrecyclable waste with recyclable waste
Water pollution	Development of different types of drainless engineering systems and water recycling procedures on the basis of wastewater treatment methods
Environmental potential	Removal of industrial enterprises from large cities and construction of new ones in sparsely populated areas with lands unsuitable for agricultural purposes; optimal location of industrial enterprises, taking into account the topography of the area and prevailing winds

Table 5. Priority matrix (selection of importance coefficients for factors F1–F12)

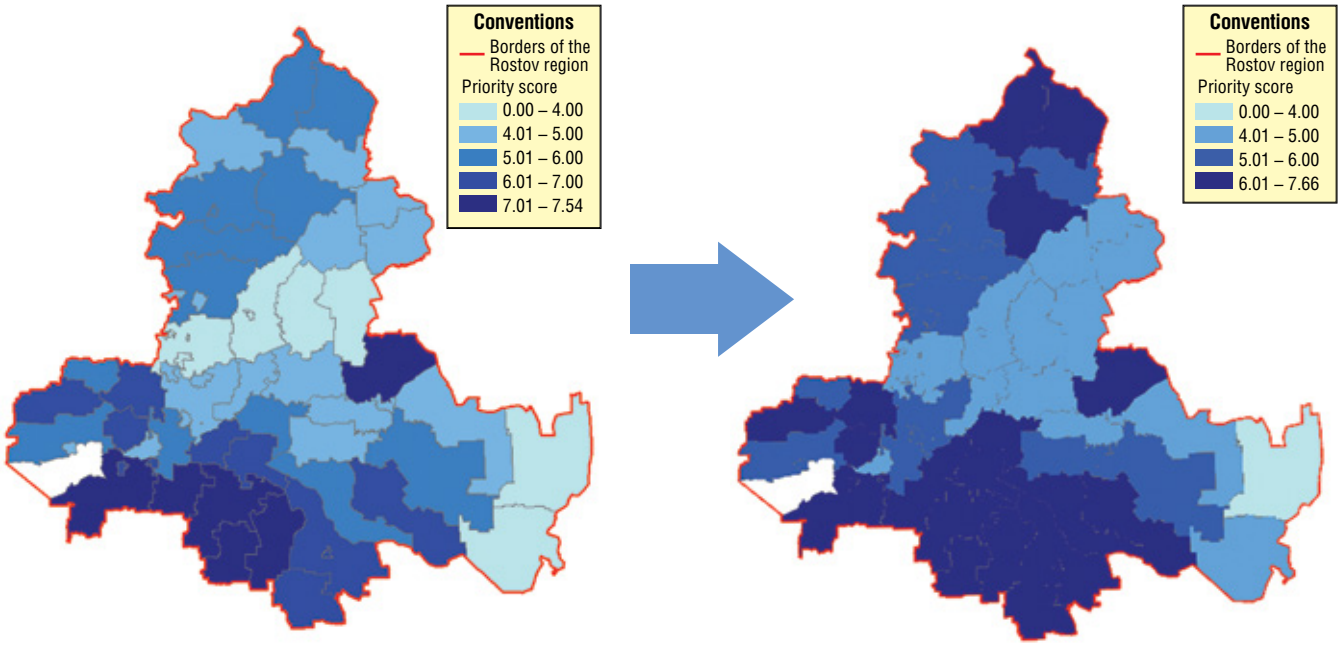
Branch	Factor											
	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11	F12
Crop farming	1	0.5	1	1	1	1	1	1	0.5	1	0	1

3 Key measures for environment protection. URL: http://ecologylib.ru/books/item/f00/s00/z0000000/st014.shtml

4 Basic processes of engineering protection of environment. URL: http://msd.com.ua/processy-inzhenernoj-zashhity-okruzhayushhej-sredy/

5 Guidelines on comprehensive assessment and functional zoning during district planning. URL: http://russianrealty.net/2014base/zastroyshchik2/rukovodstvo19.htm

6 State of Environment and its Impact on Human Health. Official web portal of the Rostov Region Government. URL: http://www.donland.ru/Default.aspx?Pageid=80952



a *b*

Fig. 4. A/C land priority rating for the purpose of crop farming in the Rostov Region: a — before the measures are taken; b — after the measures are taken

functional zones. The calculation of the rating of agricultural priority lands allows for:

- the targeted regulation of the use of territories according to their functions and suitability;
- the establishment of the optimal regime of land use for each area;
- the evaluation of the effectiveness of environmental measures and their composition according to the pre-set purposes;
- the determination of the sequence of land development, taking into account complexities and environmental conditions;
- the expansion of the developed land, taking into account the concept of sustainable development, without damaging the environment and reducing environmental risks.

REFERENCES

1. Maretskaya V.N., Maretskaya A.Yu. Methodological approach to the assessment of socio-economic development of arctic region rural areas. Bulletin of Altay Academy of Economics and Law. 2021; 12-1:120-125. DOI: 10.17513/vaael.1973 URL: https://vaael.ru/ru/article/view?id=1973 (Accessed: June 1, 2022). (rus.).
2. Serova E.V., Naumov A.S., Yanbykh R.G., Orlova N.V., Abdolova S.N. Rural development problems and new approaches to their solution in Russia. International Agricultural Journal. 2021; 6(384):10-16. DOI: 10.24412/2587-6740-2021-6-10-16 (rus.).
3. Bulanov K.A., Denisov P.V., Kosogor S.N., Vandysheva N.M., Babak V.A., Troshko K.A. et al. Module for working with earth remote sensing data in the uniform federal information system on agricultural lands. Modern Problems of Remote Sensing of the Earth from Space : collection of abstracts of the sixteenth All-Russian open conference. Moscow, November 12–16, 2018. Moscow, IKI RAN, 2018; 3. (rus.).
4. Sheina S., Fedorovskaya A., Serdiukova A. Application of Geographic Information System for forward planning of the Russian Federation subject rural areas. MATEC Web of Conferences. 2018; 196:04004. DOI: 10.1051/matecconf/201819604004
5. Timofeeva N.S. Improving the strategic planning of agricultural development in the region. Bulletin of Kemerovo State University. Series: Political, Sociological and Economic Sciences. 2020; 3(17):417-424. DOI: 10.21603/2500-3372-2020-5-3-417-424 (rus.).
6. Yang Zhou, Yurui Li, Yansui Liu. The nexus between regional eco-environmental degradation and rural impoverishment in China. Habitat International. 2020; 96:102086. DOI: 10.1016/j.habitatint.2019.102086 (Accessed: May 10, 2022).
7. Gerasimova M.I., Stroganova M.N., Mozharova N.V., Prokof'yeva T.V. Anthropogenic soils: genesis, geography, reclamation. Smolensk, Oikumena Publ., 2003; 266. (rus.).
8. Salemink K., Strijker D., Bosworth G. Rural development in the digital age: A systematic literature review on unequal ICT availability, adoption, and use in rural areas. Journal of Rural Studies. 2017; 54:360-371. DOI: 10.1016/j.jrurstud.2015.09.001
9. Rahmoun T., Zhao W., Hammad M., Hassan M. Ruralization vs. Urbanization sprawl as guiding regional planning: development scenario for rivers watershed in the southern Syrian coastal region. IOP Conference Series: Earth and Environmental Science. 2018; 151:012033. DOI: 10.1088/1755-1315/151/1/012033
10. Telichenko V.I., Shcherbina E.V. Social-natural-technogenic system of sustainable environment of vital activity. Promyshlennoe i grazhdanskoe stroitelstvo/Industrial and Civil Engineering. 2019; 6:5-12. DOI: 10.33622/0869-7019.2019.06.5-12 (rus.).
11. Shamin A.E., Proskura D.V., Denisova N.V., Frolova O.A., Proskura N.V. Classification of factors affecting the development of rural areas. Lecture Notes in Networks and Systems. 2022; 315:86-95. DOI: 10.1007/978-3-030-85799-8_8
12. Shcherbina E., Gorbenkova E. Smart city technologies for sustainable rural development. IOP Conference Series: Materials Science and Engineering. 2018; 365:022039. DOI: 10.1088/1757-899X/365/2/022039
13. Fikhtner O.A., Shvedina S.A. Sustainable development management of rural areas of the region. IOP Conference Series: Earth and Environmental Science. 2019; 341(1):012034. DOI: 10.1088/1755-1315/341/1/012034
14. Porter W.A. Integrated renewable energy for rural communities: Planning guidelines, technologies and applications, N. El Bassam, P. Maegaard, Elsevier, Amsterdam, The Netherlands (2004), 315 pp. Price: US$ 119.00 (hardback), ISBN: 0-444-51014-1. Agricultural Systems. 2005; 86(2):239-240. DOI: 10.1016/j.agsy.2005.03.009
15. Theodosiou G., Michailidis A., Loizou E., Chatzitheodoridis F. Rural areas development through endogenous potentials. Proceedings of the 118th seminar of EAAE, Rural development: governance, policy design and delivery, EAAE, Ljubljana. 2010; 931-938.

Методология повышения сельскохозяйственной пригодности земель для устойчивого развития территории

Концепция долгосрочного социально-экономического развития Российской Федерации предопределяет обеспечение устойчивого развития сельских территорий, а также повышение уровня жизни сельского населения. Оптимизировать эти процессы в рамках грамотной градостроительной политики можно путем создания геоинформационной системы их поддержки. Геоинформационные системы позволяют обеспечить устойчивое развитие территории за счет использования инструментов моделирования при планировании комплекса природоохранных мероприятий, а также мер по улучшению сельскохозяйственной пригодности земель. В статье описан процесс интеграции данных для проведения комплексной оценки территории Ростовской области, описана методология проведения данного исследования и выведены ключевые факторы, обеспечивающие показатели сельскохозяйственной пригодности земель. Представлен подготовительный этап сбора информации для создания имитационной модели. Обоснование решений по планированию развития сельских территорий также осуществляется с помощью подробной классификации земель и антропогенных факторов, влияющих на устойчивость всей ландшафтной системы субъекта Российской Федерации. Для расчета сельскохозяйственной пригодности территории используется метод объективной функции и применение матрицы приоритетов. Разработан комплекс природоохранных мероприятий, основанный на уровнях и видах ущерба и загрязнения территории субъекта Российской Федерации. Представленный комплекс мер является стандартным, но включает оценку их эффективности. Результатом исследования являются карты Ростовской области по параметру сельскохозяйственной пригодности территории для развития растениеводства до и после проведения корректирующих мероприятий. Заключение содержит выводы о перспективах использования имитационной модели, ее многогранности и преимуществах.

Ключевые слова: *устойчивое развитие, сельские поселения, имитационное моделирование, экологическая устойчивость, пригодность земель, агропромышленный комплекс, периферийные зоны, территориальное планирование*

СПИСОК ИСТОЧНИКОВ

1. Марецкая В.Н., Марецкая А.Ю. Методический подход к оценке социально-экономического развития сельских территорий арктического региона // Вестник Алтайской академии экономики и права. 2021. Т. 12-1. С. 120–125. DOI: 10.17513/vaael.1973 URL: https://vaael.ru/ru/article/view?id=1973 (дата обращения: 01.06.2022).

2. Серова Е.В., Наумов А.С., Янбых Р.Г., Орлова Н.В., Абдолова С.Н. Проблемы сельского развития и новые подходы к их решению в России // Международный сельскохозяйственный журнал. 2021. № 6 (384). С. 10–16. DOI: 10.24412/2587-6740-2021-6-10-16

3. Буланов К.А., Денисов П.В., Косогор С.Н., Вандышева Н.М., Бабак В.А., Трошко К.А. и др. Модуль работы с данными дистанционного зондирования Земли в Единой федеральной информационной системе о землях сельскохозяйственного назначения (ЕФИС ЗСН) // Современные проблемы дистанционного зондирования земли из космоса : сб. тез. докл. шестнадцатой Всеросс. открытой конф. (г. Москва, 12–16 ноября 2018 г.). М. : Институт космических исследований Российской академии наук, 2018. 3 с.

4. Sheina S., Fedorovskaya A., Serdiukova A. Application of Geographic Information System for forward planning of the Russian Federation subject rural areas // MATEC Web of Conferences. 2018. Vol. 196. P. 04004. DOI: 10.1051/matecconf/201819604004

5. Тимофеева Н.С. Совершенствование стратегического планирования развития сельского хозяйства региона // Вестник Кемеровского государственного университета. Серия: политические, социологические и экономические науки. 2020. № 3 (17). С. 417–424. DOI: 10.21603/2500-3372-2020-5-3-417-424

6. Yang Zhou, Yurui Li, Yansui Liu. The nexus between regional eco-environmental degradation and rural impoverishment in China // Habitat International. 2020; 96:102086. DOI: 10.1016/j.habitatint.2019.102086 (Accessed: May 10, 2022).

7. Герасимова М.И., Строганова М.Н., Можарова Н.В., Прокофьева Т.В. Антропогенные почвы : Генезис, география, рекультивация. Смоленск : Ойкумена, 2003. 266 с.

8. Salemink K., Strijker D., Bosworth G. Rural development in the digital age: A systematic literature review on unequal ICT availability, adoption, and use in rural areas // Journal of Rural Studies. 2017. Vol. 54. Pp. 360–371. DOI: 10.1016/j.jrurstud.2015.09.001

9. Rahmoun T., Zhao W., Hammad M., Hassan M. Ruralization vs. urbanization sprawl as guiding regional planning: development scenario for rivers watershed in the southern Syrian coastal region // IOP Conference Series: Earth and Environmental Science. 2018. Vol. 151. P. 012033. DOI: 10.1088/1755-1315/151/1/012033

10. Теличенко В.И., Щербина Е.В. Социально-природно-техногенная система устойчивой среды жизнедеятельности // Промышленное и гражданское строительство. 2019. № 6. С. 5-12. DOI: 10.33622/0869-7019.2019.06.5-12

11. Shamin A.E., Proskura D.V., Denisova N.V., Frolova O.A., Proskura N.V. Classification of factors affecting the development of rural areas // Lecture Notes in Networks and Systems. 2022; 315:86-95. DOI: 10.1007/978-3-030-85799-8_8

12. Shcherbina E., Gorbenkova E. Smart city technologies for sustainable rural development // IOP Conference Series: Materials Science and Engineering. 2018. Vol. 365. P. 022039. DOI: 10.1088/1757-899X/365/2/022039

13. Fikhtner O.A., Shvedina S.A. Sustainable development management of rural areas of the region // IOP Conference Series: Earth and Environmental Science. 2019. Vol. 341. Issue 1. P. 012034. DOI: 10.1088/1755-1315/341/1/012034

14. Wendell A.P. Integrated renewable energy for rural communities: Planning guidelines, technologies and applications, N. El Bassam, P. Maegaard, Elsevier, Amsterdam, The Netherlands (2004), 315 pp. Price: US$ 119.00 (hardback), ISBN: 0-444-51014-1 // Agricultural Systems. 2005. Vol. 86. Issue 2. Pp. 239–240. DOI: 10.1016/j.agsy.2005.03.009

15. Theodosiou G., Michailidis A., Loizou E., Chatzitheodoridis F. Rural areas development through endogenous potentials // Proceedings of the 118th seminar of EAAE, Rural development: governance, policy design and delivery, EAAE, Ljubljana. 2010. Pp. 931–938.

Об авторах: **Шеина Светлана Георгиевна** — доктор технических наук, профессор, советник РААСН, заведующая кафедрой городского строительства и хозяйства; **Донской государственный технический университет (ДГТУ)**; 344000, г. Ростов-на-Дону, Площадь Гагарина, д. 1; РИНЦ ID: 510975, Scopus: 55988259100, ResearcherID: I-3976-2014, ORCID: 0000-0001-5214-0767; rgsu-gsh@mail.ru;

Федоровская Альбина Ахмедовна — кандидат технических наук, доцент кафедры городского строительства и хозяйства; **Донской государственный технический университет (ДГТУ)**; 344000, г. Ростов-на-Дону, Площадь Гагарина, д. 1; РИНЦ ID: 679259, Scopus: 57194454315, ORCID: 0000-0002-6096-5889; bina-87@mail.ru.

For citation: Sheina S.G., Fedorovskaya A.A. Methodology for improving the agricultural suitability of land for the sustainable development of a territory. *Real estate: economics, management*. 2022; 3:36-42.

Для цитирования: *Шеина С.Г., Федоровская А.А.* Methodology for improving the agricultural suitability of land for the sustainable development of a territory // Недвижимость: экономика, управление. 2022. № 3. С. 36–42.