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FORMATION OF A MULTI-PURPOSE CADASTRE AT THE REGIONAL LEVEL

It has been proven that the transformational processes taking place in Ukraine are related to the deepening of crisis phenomena in the economic sphere, the slowdown of the main indicators of regional development, the impact of the consequences of the Covid-19 pandemic, and military operations. In such conditions, it is necessary to rethink approaches to ensure the efficiency of the functioning of regions by improving the system of land resources management, as the main factors of their development. At the same time, the modern European experience of land administration and information provision of the formation and use of real estate based on the application of the multi-purpose cadastre is considered. The aim of this work – to develop scientifically based recommendations for the formation of a multi-purpose cadastre at the regional level. To achieve the goal, the following tasks were completed: determination of the multi-purpose cadastre at the regional level; identification of factors affecting the formation of a multi-purpose cadastre; presentation of the results of mathematical modelling of the factors of formation of the multi-purpose cadastre; the formation of geo-information support of a multi-purpose cadastre. *Method.* To obtain research results, special methods are used: structural and content analysis – to form a conceptual apparatus for defining a multi-purpose cadastre at the regional level; analytical and methods of expert analysis – to determine the spatial, urban planning, investment and environmental factors of the information support of the multi-purpose cadastre; analysis of hierarchies – to determine the weighting factors characterizing the mutual influence of indicators of information provision of the multi-purpose cadastre; mathematical modelling – for the development of models that determine the impact of spatial, urban planning, investment and environmental factors on the integral indicator of information provision of the multi-purpose cadastre; correlation-regression analysis – to establish the influence of the integral indicator of information provision of the multi-purpose cadastre at the regional level on the gross regional product; of geo-information analysis – for the development of geo-information support of the multi-purpose cadastre. *Scientific novelty and practical significance*. An integral indicator for assessing the level of information provision of the multi-purpose cadastre is proposed, which is determined based on spatial, urban planning, investment and environmental factors, which allows forming the information basis for the development of scientifically based recommendations for the creation and implementation of the multi-purpose cadastre at the regional level. The concept of "multi-purpose cadastre at the regional level" was defined, which considers the totality of spatial, urban planning, investment and environmental support, which allowed to build a multi-level information system for the formation of a quantitative basis of real estate management at the regional level. The method of integral assessment of the level of information support of the multi-purpose cadastre at the regional level is characterized, which is based on a multi-level system of factors, methods of assessment of analytical and qualitative indicators, analysis of hierarchies, local, generalizing and integral models, which made it possible to carry out mathematical modelling of these factors, to form geo-information support for adoption reasoned decisions in the field of real estate management. The results of mathematical modelling of the processes of development of information support of a multi-purpose cadastre based on the establishment of relationships between system factors and an integral indicator by applying the method of correlation-regression analysis are presented, which makes it possible to build predictive models and establish trends in the formation and use of real estate at the regional level, taking into account the spatial, urban planning, investment and environmental support. Scientifically based recommendations for the development and implementation of a multi-purpose cadastre were proposed based on the results of their level assessment and modelling, which made it possible to single out directions for increasing the level of information provision and application of the multi-purpose cadastre for increasing the efficiency of real estate use at the regional level [Holovachov et al., 2022; Holovachov, 2022].

Key words: multipurpose cadastre; land use; spatial; urban planning; investment; environmental factors; scientifically based recommendations; information support.

Introduction

The transformational processes that are taking place in Ukraine relate to the deepening of crisis phenomena in the economic sphere, the slowdown of the main indicators of regional development, the impact of the consequences of the Covid-19 pandemic, and military actions. In such conditions, it is necessary to rethink approaches to ensure the efficiency of the functioning of regions by improving

the system of land resources management, as the main factors of their development.

The land administration system requires re-engineering of the existing state of land relations regulation and management of the use of land resources in Ukraine, which indicates the need to implement a multi-purpose cadastre for the systematic management of land relations [Shypulin, 2016].

Scientists from different countries are actively engaged in the problem of multi-purpose cadastre and real estate research. In particular [Maksyshko, Shapovalova, 2012], revealed the regional stratification and structural heterogeneity of real estate in Ukraine and indicated the extremely high relevance of real estate market research.

The use of multi-purpose cadastres of the integrated land information system as an information basis for assessing the state and optimizing land use makes it possible to provide the necessary indicators of the quality of management decisions made [Taratula, 2017].

Approaches to the formation of a multi-purpose cadastre should take place by ensuring the systematic implementation of land administration functions (ownership, assessment, use and development of land) considering and solving legal, economic, ecological, urban planning and management tasks for the creation of a unified geoinformation system [Pyrkova, 2015].

[Mamonov, 2019] identified the factors affecting the territorial development of land use in the region and proposed a methodological approach of integral assessment of the territorial development of land use in the region. And scientists [Shypulin et al., 2019] considered the methods of collecting initial information when building three-dimensional models of real estate objects in the aspect of a multi-purpose cadastre.

Scientists divide real estate into three groups. The first group consists of real estate objects, which are classified there according to their functional purpose. The second group of real estate consists of objects located on a plot of land, the movement of which is impossible without depreciating them and changing their purpose. The third group consists of movable objects to which the law applies the legal regime of immovable property (sea, aircraft, space objects) [Hrushchynska, 2020].

The improvement of the structure of the land information system boils down to the fact that the data of the state land cadastre, monitoring and land management on qualitative and quantitative characteristics, as well as ecological and economic indicators (intensity and efficiency of the use of land resources) of land use are considered through the integration of information blocks of the database [Taratula, 2016].

At the same time, the modern European experience of land administration and information provision of the formation and use of real estate based on the application of the multi-purpose cadastre is considered.

As a result of their project, scientists [Williamson, Enemark and Wallace, 2006] developed a model of land resource management, the purpose of which is to combine Australian and European experience. The model was built to define the goals and structures of the national land management system to help nations articulate their needs for coordination, capacity building, technological reforms, and common projects.

[Eriksson, 2005] reviewed the legislation on the formation of multidimensional real estate (3D cadastre) that came into force in Sweden in 2004 and emphasized that the law is considered the most important change that has occurred in the cadastral legislation of Sweden.

[Stoter, et al., 2004] studied the three-dimensional cadastre, which is an integral part of the multipurpose cadastre. Scientists have described several conceptual models for improving cadastral registration. To confirm the potential of the model, they studied several countries and states where it is already possible to create 3D property objects with separate ownership from legal points of view (Norway, Sweden, Queensland and British Columbia). Scientists applied a prototype of a complete 3D cadastre model to the example of the city of Queensland (Australia).

The scientist [Eric, & Hall, 2017] singled out the Multi-Sector Sustainability Browser (MSSB) is a decision support tool (DST) designed to synthesize and summarize research in the four decision-making areas of sustainable development, land use, buildings and infrastructure, transport and materials management in such a way as to provide easy and quick access to information for use in planning and decision-making.

And scientists [Carpenter and Snell, 2020] in their report conducted a high-level analysis of the main global geospatial factors and trends, which, according

to forecasts, will have the greatest impact on the management of geospatial information during the next five to ten years. They identified that industry change is driven by a variety of drivers and trends, with the top five identified as: technological progress, the emergence of new data sources, changing user demands, industry change, and the regulatory and policy environment.

The development and implementation of a multi-purpose cadastre at the regional level is determined by the need to improve the information support of land relations, the use of real estate objects, considering a complex of spatial, urban planning, environmental and investment factors. For the development of information support of the multi-purpose cadastre at the regional level, the application of modern geoinformation systems in determining the possibilities of transition from the 2D cadastre to the "new" generation 3D and 4D cadastres is an urgent issue.

Thus, the research topic is relevant, and its development is timely.

Aim

The purpose of the study is to develop scientifically based recommendations for the formation of a multi-purpose cadastre at the regional level. To achieve the set goal, the following tasks were completed:

– definition of a multi-purpose cadastre at the regional level;

– identification of factors affecting the formation of a multi-purpose cadastre;

– presentation of the results of mathematical modelling of the factors of formation of the multi-purpose cadastre;

– the formation of geo-information support of a multi-purpose cadastre.

Research methodology

Based on theoretical provisions, directions and features of the formation and use of information support, characteristics of real estate, the definition of a multi-purpose cadastre as a multi-level information system is proposed, which is aimed at the formation and use of real estate, which is created based on spatial, urban planning, environmental and investment support, considering the interaction of various groups of stakeholders for territorial development of regions.

Factors affecting the formation of a multi-purpose cadastre at the regional level are singled out: spatial, urban, investment, environmental.

The proposed stages of development and implementation of the integral method of assessing the level of information support of the multi-purpose cadastre at the regional level:

1. Formation of information and analytical support for the integrated assessment of the level of information support of the multi-purpose cadastre at the regional level.
2. Selection of integrated assessment indicators.
3. Formation of a multi-level system of factors of integral assessment of the level of information support of the multi-purpose cadastre at the regional level.
4. Directions for determining local indicators.
5. Construction of generalized evaluation models.
6. Determination of the generalizing indicators of the integrated assessment of the level of information support of the multi-purpose cadastre at the regional level.
7. Construction of an integral evaluation model.
8. Determination of weighting factors.
9. Evaluation of the integral indicator of the level of information provision of the multi-purpose cadastre at the regional level.
10. Interpretation of the obtained results.

Local indicators are determined by methods of expert analysis and absolute methods. The construction of generalized evaluation models is carried out based on the relevant indicators of the multi-level system and local factors using the geometric mean formula:

spatial indicators (I_{bc1}):

$$I_{bc1} = \sqrt[3]{i_{bc11} * i_{bc12} * i_{bc13}}; \quad (1)$$

urban planning indicators (I_{bc2}):

$$I_{bc2} = \sqrt[11]{\begin{matrix} i_{bc21} * i_{bc22} * i_{bc23} * i_{bc24} * i_{bc25} * i_{bc26}. \\ * i_{bc27} * i_{bc28} * i_{bc29} * i_{bc210} * i_{bc211} \end{matrix}}, \quad (2)$$

environmental indicators (I_{bc3}):

$$I_{bc3} = \sqrt[12]{\begin{matrix} i_{bc31} * i_{bc32} * i_{bc33} * i_{bc34} * i_{bc35} * i_{bc36} \\ * i_{bc37} * i_{bc38} * i_{bc39} * i_{bc310} * i_{bc311} * i_{bc312} \end{matrix}}, \quad (3)$$

investment indicators (I_{bc4}):

$$I_{bc4} = \sqrt[7]{\begin{matrix} i_{bc41} * i_{bc42} * i_{bc43} * i_{bc44} * i_{bc45} * i_{bc46} \\ * i_{bc47} \end{matrix}}. \quad (4)$$

The determination of the general indicators of the integrated assessment of the level of information provision of the multi-purpose cadastre at the regional level is carried out based on the models presented above.

An integrated model for assessing the level of information support was built:

$$I_{bc} = \sqrt{I_{bc1} * k_{vbc1} + I_{bc2} * k_{vbc2} + I_{bc3} * k_{vbc3} + I_{bc4} * k_{vbc4}}, \quad (5)$$

where k_{vbc1}, k_{vbc2}, k_{vbc3}, k_{vbc4} – weighting coefficients of the impact of generalizing indicators on the integral criterion for assessing the level of information provision of the multi-purpose cadastre at the regional level.

The assessment of weighting factors is carried out using the method of analysis of hierarchies, the implementation of which includes the following areas:

– the formation of information and analytical support regarding the mutual influence of generalizing indicators and their influence on the integral factor of assessing the level of information support of the multi-purpose cadastre at the regional level;

– creation of a quantitative base of experts for research, determined at the level of 22 people;

– application of information on the results of the evaluation of general indicators: spatial (I_{bc1}), urban planners (I_{bc2}), environmental (I_{bc3}), investments (I_{bc4});

– carrying out a pairwise comparison of the mutual influence of generalizing indicators and their influence on the integral factor of assessing the level of information support of the multi-purpose cadastre at the regional level based on the proposed scale of T. Saati;

– construction of a matrix of mutual influence of generalizing indicators relative to the integral factor of assessing the level of information support of the multi-purpose cadastre at the regional level ($A_{I_{bci}}$):

$$A_{I_{bci}} = \begin{bmatrix} 1 & I_{bc1}/I_{bc2} & I_{bc1}/I_{bc3} & I_{bc1}/I_{bc4} \\ I_{bc2}/I_{bc1} & 1 & I_{bc2}/I_{bc3} & I_{bc2}/I_{bc4} \\ I_{bc3}/I_{bc1} & I_{bc3}/I_{bc2} & 1 & I_{bc3}/I_{bc4} \\ I_{bc4}/I_{bc1} & I_{bc4}/I_{bc2} & I_{bc4}/I_{bc3} & 1 \end{bmatrix}; \quad (6)$$

determination of the components of the eigenvector for generalizing indicators:
spatial:

$$K_{I_{bc1}} = \sqrt[4]{1 * {I_{bc1}}/{I_{bc2}} * {I_{bc1}}/{I_{bc3}} * {I_{bc1}}/{I_{bc4}}}; \quad (7)$$

urban planners:

$$K_{I_{bc2}} = \sqrt[4]{{I_{bc2}}/{I_{bc1}} * 1 * {I_{bc2}}/{I_{bc3}} * {I_{bc2}}/{I_{bc4}}}; \quad (8)$$

environmental:

$$K_{I_{bc3}} = \sqrt[4]{{I_{bc3}}/{I_{bc1}} * {I_{bc3}}/{I_{bc2}} * 1 * {I_{bc3}}/{I_{bc4}}}; \quad (9)$$

investments:

$$K_{I_{bc4}} = \sqrt[4]{I_{bc4}/I_{bc1} * I_{bc4}/I_{bc2} * I_{bc4}/I_{bc3} * 1}; \quad (10)$$

determination of weighting coefficients for summarizing indicators:
spatial:

$$k_{vbc1} = \frac{K_{I_{bc1}}}{(K_{I_{bc1}}+K_{I_{bc2}}+K_{I_{bc3}}+K_{I_{bc4}})}; \quad (11)$$

urban planners:

$$k_{vbc2} = \frac{K_{I_{bc2}}}{(K_{I_{bc1}}+K_{I_{bc2}}+K_{I_{bc3}}+K_{I_{bc4}})}; \quad (12)$$

environmental:

$$k_{vbc3} = \frac{K_{I_{bc3}}}{(K_{I_{bc1}}+K_{I_{bc2}}+K_{I_{bc3}}+K_{I_{bc4}})}; \quad (13)$$

investments:

$$k_{vbc4} = \frac{K_{I_{bc4}}}{(K_{I_{bc1}}+K_{I_{bc2}}+K_{I_{bc3}}+K_{I_{bc4}})}; \quad (14)$$

An approach to the estimation of weight coefficients based on the method of analysis of hierarchies is proposed. Along with this, to ensure the reliability of the results obtained in the work, this method was modified on the basis of improving the directions of pairwise comparisons, building a matrix of alternatives, and determining correction coefficients.

The degree of reliability of the simulation model of the level of information provision of the multi-purpose cadastre of regions is fully determined by the well-founded selection of corrective coefficients. It is proposed when choosing the correcting coefficients of the modified method of analysis of hierarchies. The most important advantage of this method is the possibility for the decision-maker not to issue as the "correct" decision the conclusions made based on his own experience, but to find in an interactive mode the option that best corresponds to the essence of the problem. This method is not based on a large amount of information received from experts, it is dynamic, that is, with the change of the given advantages, the criterion indicators also change.

Thus, the priority variants of the values of the weighting coefficients of the indicators of the level of information provision of the multi-purpose cadastre of the regions can be applied when building a simulation model, and the presented algorithm for their selection allows obtaining an agreed result on groups of indicators of different sizes and when analysing any number of options presented by experts.

The assessment of the integral indicator of the level of information support of the multi-purpose cadastre at the regional level is carried out based on the appropriate integral model.

The interpretation of the obtained results forms a quantitative basis and a theoretical basis for substantiating directions for the creation and implementation of information support of the multi-purpose cadastre. Based on the obtained results, mathematical modelling of changes in the integral indicator, its forecasting and the formation of reasonable decisions regarding the increase in the efficiency of land relations are carried out, using modern information support of the multi-purpose cadastre at the regional level.

Research results

Thus, because of the research, an integral method of assessing the level of information support of the multi-purpose cadastre at the regional level was developed. The application of this method allows creating a quantitative basis for decision-making regarding the increase in the efficiency of the for-

mation and use of multi-purpose cadastre at the regional level. In addition, the results of the implementation of the integral method create a basis for the construction of the algorithm for the implementation of the multi-purpose cadastre at the regional level.

The results of the numerical experiment on the evaluation of the integral indicator of the information provision of the multi-purpose cadastre at the regional level (I_{bc}) with the use of four sets of values of the weighting coefficients are presented in Table 1.

Table 1

The results of the assessment of the integral indicator of the information support of the multi-purpose cadastre at the regional level (I_{bc}) using four sets of values of weighting factors, rel. units

Regions	$I_{bc},\{k_{vbci}\}^{(1)}$	$I_{bc},\{k_{vbci}\}^{(2)}$	$I_{bc},\{k_{vbci}\}^{(3)}$	$I_{bc},\{k_{vbci}\}^{(4)}$
Vinnytsia	0.096	0.089	0.088	0.089
Volynskyi	0.195	0.187	0.181	0.185
Dnipropetrovsk	0.119	0.131	0.121	0.131
Donetsk	0.186	0.245	0.215	0.244
Zhytomyrskyi	0.149	0.139	0.136	0.138
Transcarpathian	0.229	0.215	0.207	0.207
Zaporozhye	0.193	0.208	0.192	0.204
Ivano-Frankivsk	0.115	0.107	0.105	0.107
Kyivskyi	0.137	0.135	0.130	0.135
Kirovohradskyi	0.368	0.459	0.408	0.456
Luhansk	0.548	0.773	0.669	0.772
Lviv	0.310	0.341	0.316	0.341
Mykolaivskyi	0.136	0.153	0.140	0.152
Odesa	0.172	0.232	0.202	0.231
Poltava	0.105	0.103	0.096	0.096
Rivne	0.148	0.153	0.139	0.142
Sumy	0.144	0.154	0.142	0.151
Ternopilskyi	0.178	0.245	0.213	0.244
Kharkiv	0.218	0.250	0.229	0.250
Khersonskyi	0.329	0.329	0.315	0.329
Khmelnytskyi	0.305	0.306	0.282	0.285
Cherkasy	0.497	0.449	0.445	0.445
Chernivtsi	0.120	0.117	0.112	0.116
Chernihivskyi	0.129	0.152	0.137	0.151

The integral indicator I_{bc} characterizes the level of information provision of the multi-purpose cadastre in each region. The highest values of the I_{bc} indicator are observed in regions in which deviations from the baseline are either insignificant or take positive values for each group of indicators. The level of influence on the final result of spatial, urban planning, environmental and investment indicators in individual regions differs significantly. The assessment of this impact is reflected in weighting factors. According to the results of the numerical experiment, the value of the integral indicator depends on the choice of a set of weighting factors, that is why in each region the degree of influence of system group indicators, expressed in weighting factors, should be investigated.

The analysis of the integral indicator in accordance with its level of information support of the multi-purpose cadastre at the regional level is carried out according to Table. 2.

Table 2

Correspondence of the value of the integral indicator to the level of information support of the multi-purpose cadastre at the regional level

Range of values	The level of information provision of the multi-purpose cadastre
0–0.199	Insufficient
0.2–0.399	Weak
0.4–0.599	Moderate
0.6–0.799	Sufficient
0.8–1.000	High

A comparison of the results of a numerical experiment on finding the integral indicator with different values of the weighting coefficients confirms the observation of the proportionality of the group components of the information support indicators of the multi-purpose cadastre. The calculated values of the integral indicator for each of the four sets of weighting factors proposed by the experts allow identical interpretation of the level of information provision of the multi-purpose cadastre of each of the regions.

Thus, as a result of the study, it was established that in most regions there is an insufficient, weak or moderate level of information provision of the multi-purpose cadastre at the regional level.

Therefore, the obtained results indicate the need for the formation of scientifically based recommendations for the development and implementation of a multi-purpose cadastre at the regional level, the creation of its information support, considering spatial, urban planning, investment and environmental factors.

For the development and implementation of the multi-purpose cadastre and the formation of its information support, geo-information support is proposed (Fig. 1–8).

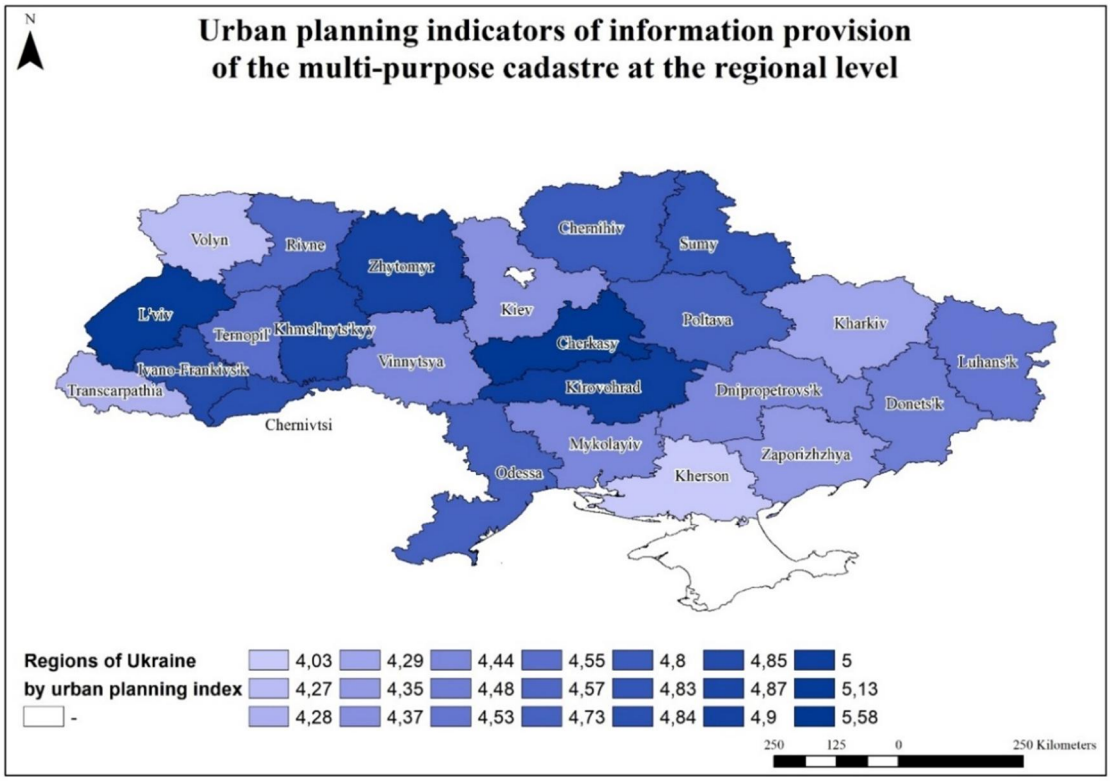

Fig. 1. Geoinformation provision of urban planning indicators of information provision of the multi-purpose cadastre at the regional level, rel. units

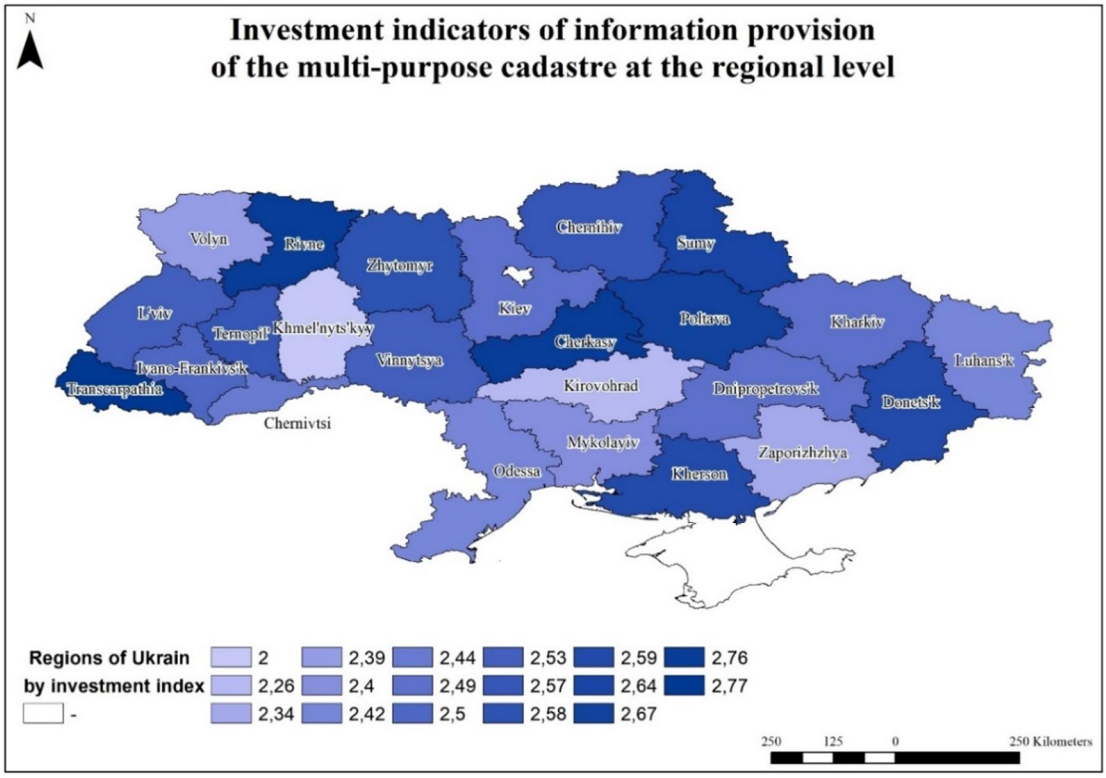

Fig. 2. Geoinformation provision of investment indicators of information provision of the multi-purpose cadastre at the regional level, rel. units

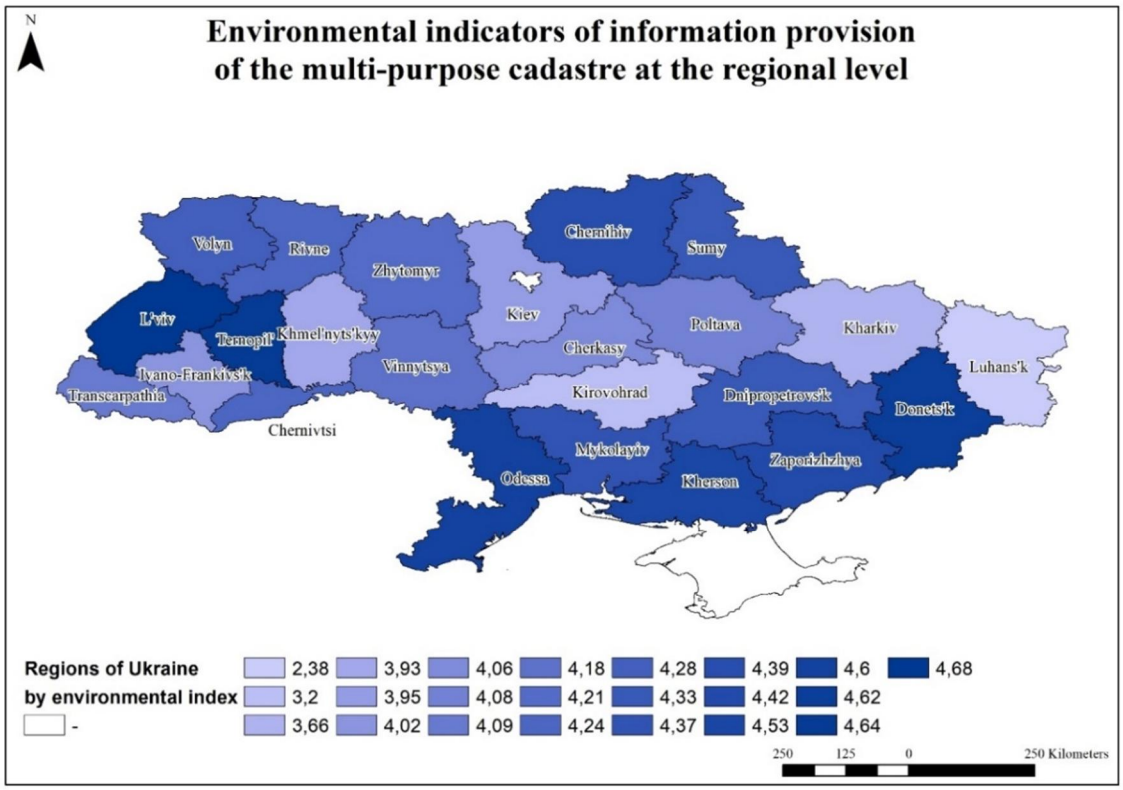

Fig. 3. Geoinformation provision of environmental indicators of information provision of the multi-purpose cadastre at the regional level, rel. units

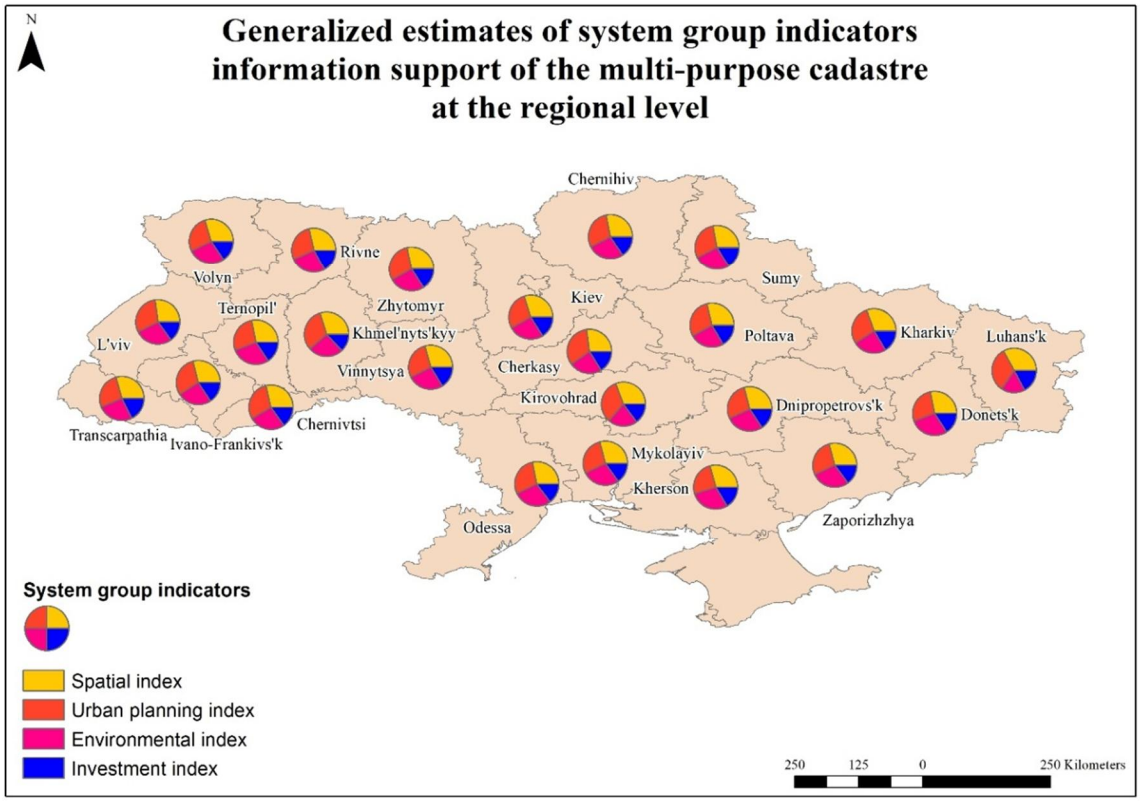

Fig. 4. Geoinformation provision of system group information provision of multi-purpose cadastre at the regional level, rel. units

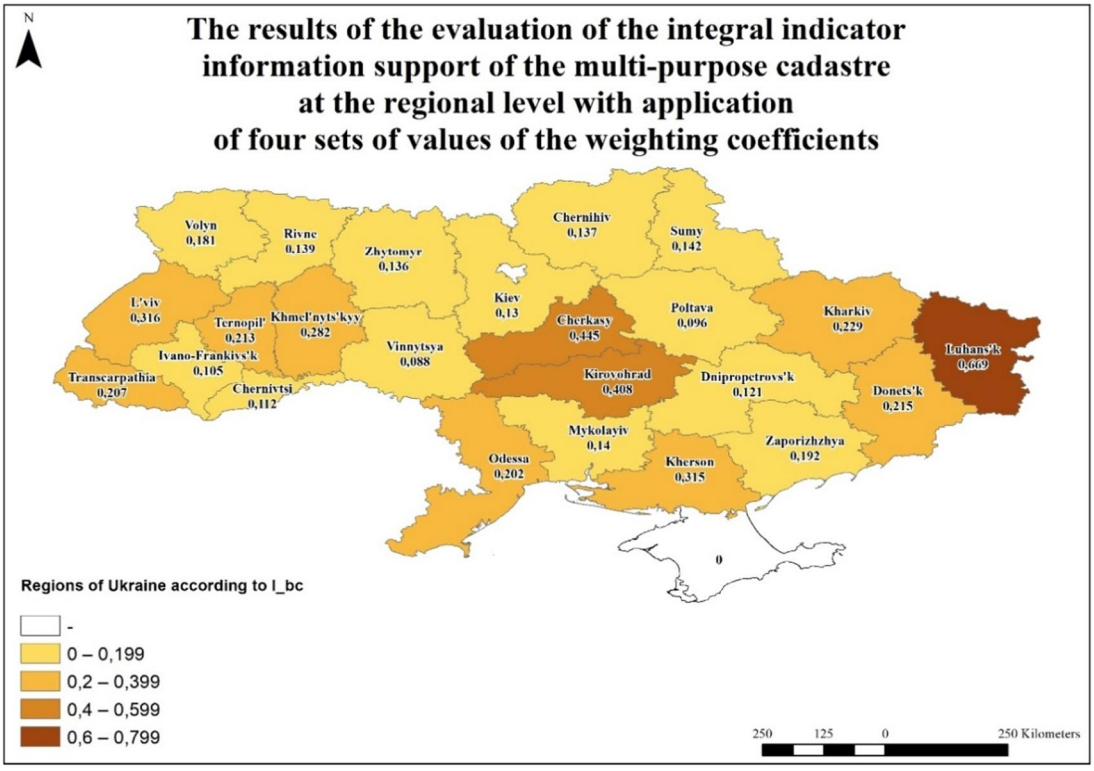

Fig. 5. Geoinformation support of the integral indicator of information support of the multi-purpose cadastre at the regional level, rel. units

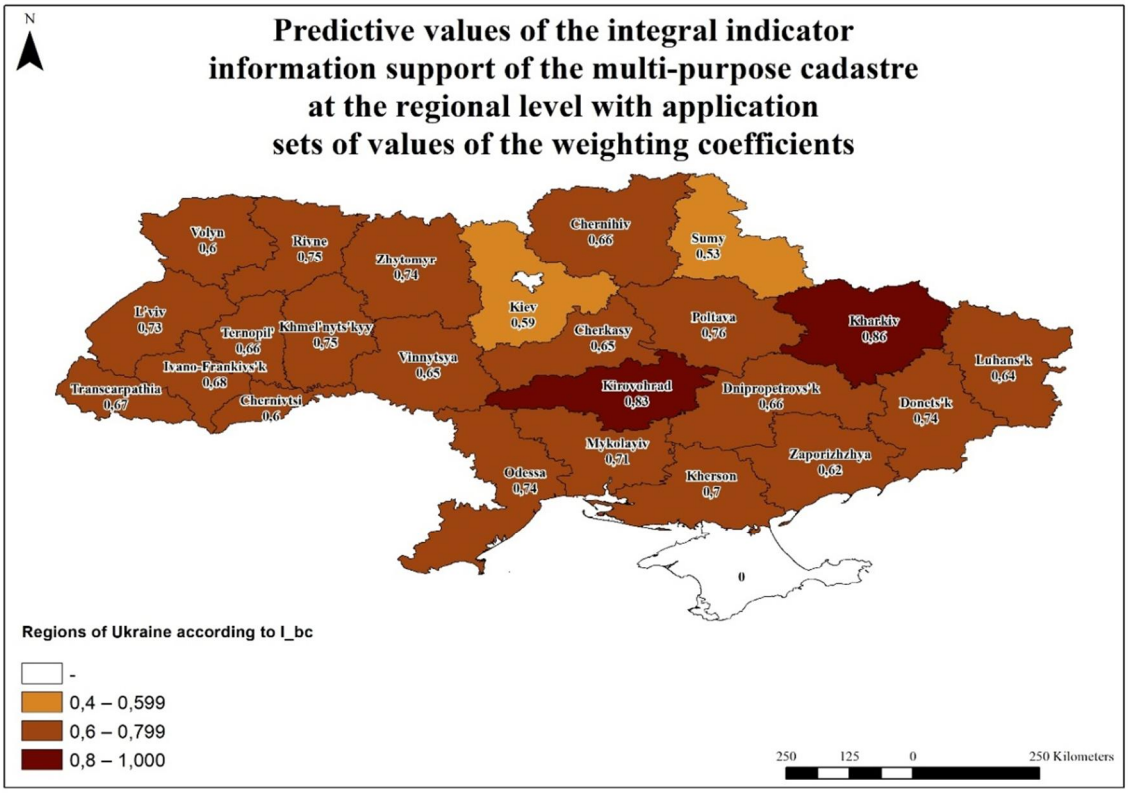

Fig. 6. Geoinformation provision of forecast values of the integral indicator of information provision of the multi-purpose cadastre at the regional level, rel. units

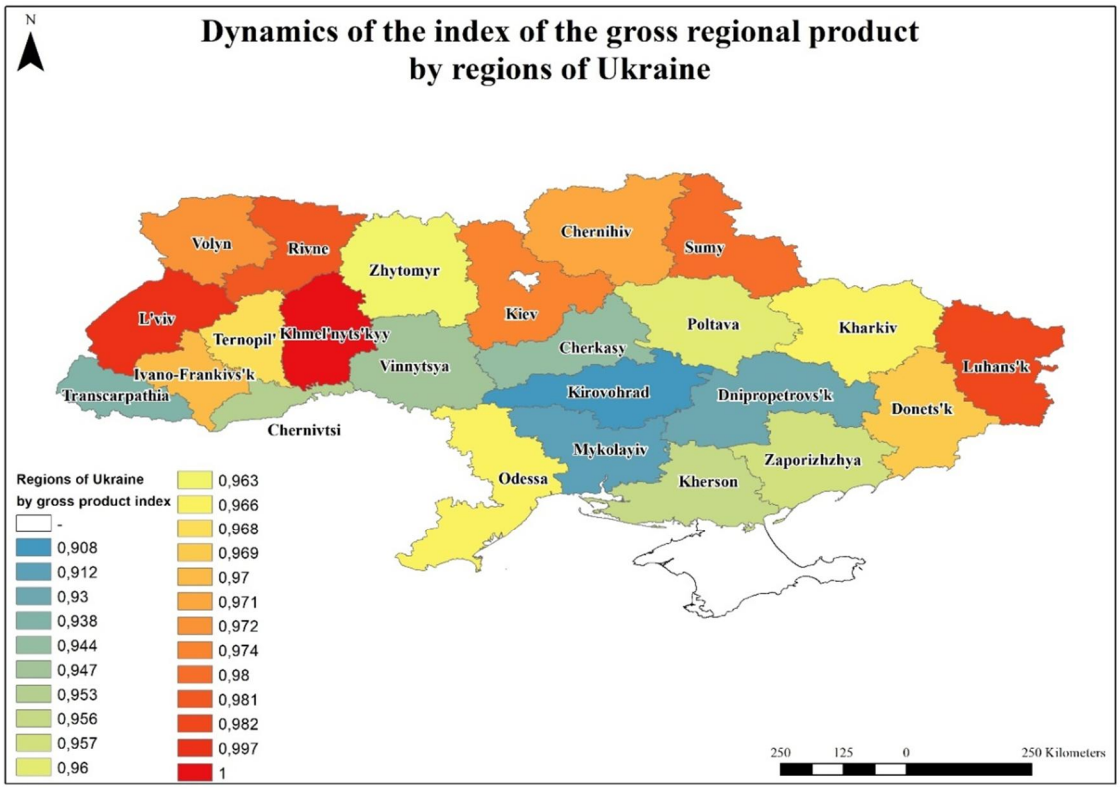

Fig. 7. Geoinformation provision of the gross regional product index, rel. units

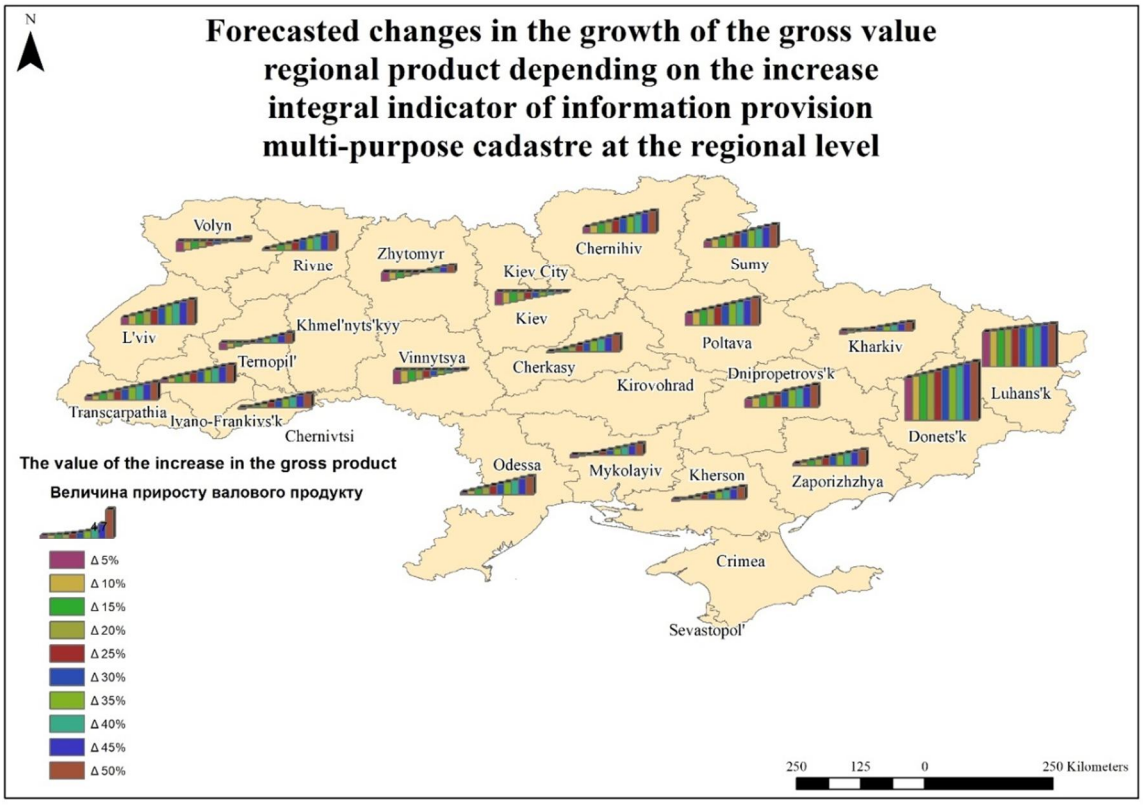

Fig. 8. Geoinformation provision of forecast values of changes in the gross regional product depending on the increase in the integral indicator of the information provision of the multi-purpose cadastre at the regional level, rel. units

Geoinformation support allows for the formation of a monitoring environment as an important component of information support for the formation and implementation of a multi-purpose cadastre at the regional level, considering the influence of spatial, urban planning, investment and environmental factors. The development of geoinformation provides opportunities to create a solution on the use of real estate based on the visualization of changes during the relevant period. In addition, during the formation of geo-information support, forecast changes in the integral indicator of information support of the multi-purpose cadastre are considered, which creates a quantitative basis for decision-making for regional development.

Scientific novelty and practical relevance

Thus, the Scientific novelty of the conducted research consists in the development of a multi-level system, which includes the local, generalizing and integral level, where the factors of determining the level of information support of the multi-purpose cadastre at the regional level are formed on the basis of models that allow permanent monitoring of their changes for the implementation of the integral assessment method.

Conclusions

The article proposes an integral indicator for assessing the level of information provision of the multi-purpose cadastre, which is determined on the basis of spatial, urban planning, investment and environmental factors, which allows forming the information basis for the development of scientifically based recommendations for the creation and implementation of the multi-purpose cadastre at the regional level.

The concept of "multi-purpose cadastre at the regional level" was defined, which considers the totality of spatial, urban planning, investment and environmental support, which allowed to build a multi-level information system for the formation of a quantitative basis of real estate management at the regional level.

The method of integral assessment of the level of information support of the multi-purpose cadas-

tre at the regional level is characterized, which is based on a multi-level system of factors, methods of assessment of analytical and qualitative indicators, analysis of hierarchies, local, generalizing and integral models, which made it possible to carry out mathematical modelling of these factors, to form geo-information support for adoption reasoned decisions in the field of real estate management.

The results of mathematical modelling of the processes of development of information support of a multi-purpose cadastre based on the establishment of relationships between system factors and an integral indicator by applying the method of correlation-regression analysis are presented, which makes it possible to build predictive models and establish trends in the formation and use of real estate at the regional level, taking into account the spatial, urban planning, investment and environmental support.

The results of mathematical modelling of regional development are determined based on the results of correlation-regression analysis of changes in the integral indicator of the assessment of the information support of the multi-purpose cadastre and the gross regional product, which allows to establish forecast changes and build geospatial support for regional development.

Scientifically based recommendations for the development and implementation of a multi-purpose cadastre were proposed based on the results of their level assessment and modelling, which made it possible to single out directions for increasing the level of information provision and application of the multi-purpose cadastre for increasing the efficiency of real estate use at the regional level.

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ФОРМУВАННЯ БАГАТОЦІЛЬОВОГО КАДАСТРУ НА РЕГІОНАЛЬНОМУ РІВНІ

Доведено, що трансформаційні процеси, які відбуваються в Україні, пов’язані із поглибленням кризових явищ у сфері економіки, уповільненням основних показників регіонального розвитку, впливом наслідків пандемії Covid-19 та військових дій. У таких умовах потребують переосмислення підходи до забезпечення ефективності функціонування регіонів із удосконаленням системи управління земельними ресурсами як основними чинниками їх розвитку. Потрібно враховувати сучасний європейський досвід земельного адміністрування та інформаційного забезпечення формування і використання нерухомості на основі застосування багатоцільового кадастру. Мета дослідження – розроблення науково обґрунтованих рекомендацій щодо формування багатоцільового кадастру на регіональному рівні. Для досягнення поставленої мети виконано такі завдання: визначення багатоцільового кадастру на регіональному рівні; виокремлення чинників, що впливають на формування багатоцільового кадастру; подання результатів математичного моделювання чинників формування багатоцільового кадастру; формування геоінформаційного забезпечення багатоцільового кадастру. *Методика*. Для отримання результатів дослідження застосовано спеціальні методи: структурно-змістового аналізу – для формування понятійного апарату щодо визначення багатоцільового кадастру на регіональному рівні; аналітичних та методів експертного аналізу – для визначення просторових, містобудівних, інвестиційних і екологічних чинників інформаційного забезпечення багатоцільового кадастру; аналізу ієрархій – для визначення вагових коефіцієнтів, що характеризують взаємний вплив показників інформаційного забезпечення багатоцільового кадастру; математичного моделювання – для розроблення моделей, що визначають вплив просторових, містобудівних, інвестиційних й екологічних чинників на інтегральний показник інформаційного забезпечення багатоцільового кадастру; кореляційно-регресійного аналізу – для встановлення впливу інтегрального показника інформаційного забезпечення багатоцільового кадастру на регіональному рівні на валовий регіональний продукт; геоінформаційного аналізу – для розроблення геоінформаційного забезпечення багатоцільового кадастру. *Наукова новизна та практична значущість*. Запропоновано інтегральний показник оцінювання рівня інформаційного забезпечення багатоцільового кадастру, який визначається на основі просторових, містобудівних, інвестиційних і екологічних чинників, що дає змогу сформувати інформаційне підґрунтя для розроблення науково обґрунтованих рекомендацій щодо створення й упровадження багатоцільового кадастру на регіональному рівні. Визначено поняття “багатоцільовий кадастр на регіональному рівні”, яке враховує сукупність просторового, містобудівного, інвестиційного й екологічного забезпечення, що дало змогу побудувати багаторівневу інформаційну систему для формування кількісної основи управління нерухомістю на регіональному рівні. Охарактеризовано метод інтегрального оцінювання рівня інформаційного забезпечення багатоцільового кадастру на регіональному рівні, який ґрунтується на багаторівневій системі чинників, методах оцінювання аналітичних і якісних показників, аналізу ієрархій, локальних, узагальнювальних й інтегральній моделях, що дало змогу здійснити математичне моделювання цих чинників, сформувати геоінформаційне забезпечення для прийняття обґрунтованих рішень у сфері управління нерухомістю. Викла-

дено результати математичного моделювання процесів розроблення інформаційного забезпечення багатоцільового кадастру на основі встановлення зв'язків між системними чинниками й інтегральним показником із застосуванням методу кореляційно-регресійного аналізу, що надає можливість побудувати прогнозні моделі й встановити тенденції формування та використання нерухомості на регіональному рівні, враховуючи просторове, містобудівне, інвестиційне й екологічне забезпечення. Запропоновані науково обґрунтовані рекомендації щодо розроблення й упровадження багатоцільового кадастру на основі результатів оцінювання їх рівня та моделювання, що дало змогу виокремити напрями підвищення рівня інформаційного забезпечення й застосування багатоцільового кадастру для підвищення ефективності використання нерухомості на регіональному рівні [Головачов та ін., 2022; Головачов, 2022].

Ключові слова: багатоцільовий кадастр; використання земель, просторові, містобудівні, інвестиційні, екологічні чинники; науково обґрунтовані рекомендації; інформаційне забезпечення.

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