

Original paper

The main conceptual provisions of the territorial development of the regional land use

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Abstract: The purpose of the article is to substantiate the basic conceptual provisions for determining the territorial development of regional land use. In accordance with the purpose, the following tasks have been solved: substantiation of theoretical provisions for determining the territorial development of regional land use; determination of features of territorial development of regional land use; formation of hypotheses on the influence of spatial, urban, investment and environmental factors. Peculiarities of territorial development of regional land use are determined. Legal support is proposed. The international practices for ensuring the territorial development of regional land use are summarized, the main directions of which are: the formation and development of land relations on a long-term basis, the determination of the target and functional purpose of lands, the constant registration of cadastral information with the formation of an ecological balance of the land use and considering the peculiarities of interaction between groups of stakeholders. The system of land administration, where its functions (land ownership, valuation, use, development of land) are comprehensively implemented and interact, in the territorial development of regional land use is of particular importance. The geographic information systems are widely used as a tool for the formation, processing and application of information on the territorial development of the regional land use in modern land administration systems. The mathematical modelling of the influence of factors on the territorial development of regional land use has been carried out.

Keywords: mathematical modelling, territorial development, regional land use



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1. Introduction

The solution of the problem, the structural component of which is the formation of a theoretical and methodological platform for determining the territorial development of land use in regions is based on the systematization and formation of theoretical and methodological foundations for determining the territorial development of land use in regions, the results of analysis of its state and paradigmatic changes.

Modern conditions of regional land use require a rethinking of approaches to determining their territorial development. The dominant nature of territorial development is determined by globalization processes, the movement towards European institutions, the negative impact of external factors, internal economic instability, the optimization of relations in territorial systems of different levels. During 2004–2016, there was a slowdown in the growth rate of gross regional product from 12.1% to 2.4%, respectively. In 2017–2018 there is a slight increase in the rate of gross regional product to 2.5 and 3.3% ([State Statistics Service of Ukraine, 2020](#)).

In 2016–2017, the volume of capital investments in the regional aspect increased by 27%, the rate of increase in the index of industrial products slowed down by 2.4%, and the index of construction products increased by 8.9%. Changes in the presented indicators in 2018 are characterized by similar trends. At the same time, the environmental situation is deteriorating in the regional aspect. During 2015–2016, there is an increase in emissions of pollutants and carbon dioxide into the atmosphere from stationary sources of pollution by 7.7%. In 2017–2018, the trend is changing due to the reduction of the presented indicator compared to 2016 by 16% and 18.5%, respectively ([State Statistics Service of Ukraine, 2020](#)). Thus, the relevance of the research topic is determined by the need for further study of the problem, which consists in resolving the contradictions between low-structured activity and fuzzy processes of organization and use of land resources in the regions of Ukraine, leading to conflict situations in land relations and modern methods, techniques and technologies that ensure the territorial development of land use in region. In the context of the problem, the issues of forming a theoretical and methodological platform for determining the territorial development of regional land use are identified.

In the existing scientific developments the theoretical provisions on land use and territorial development are defined and substantiated in ([Blandinier, 2001](#); [Tretyak and Babmindra, 2003](#); [Petrakovska, 2005](#); [Palekha, 2009](#); [Williamson et al., 2010](#); [Martin, 2011](#); [Perovich, 2011](#); [Stupen et al., 2011](#); [Shipulin, 2014](#); [2016](#)). Despite the significant number of scientific developments on land use and territorial development, the issues of its systemic provision at the regional level have not been resolved, taking into account the impact of spatial, urban, investment and environmental factors. The purpose of the article is to substantiate the main conceptual provisions for determining the territorial development of regional land use. In accordance with the goal the following tasks are solved:

- substantiation of theoretical provisions for determining the land use territorial development in regions;
- determination of the features of land use territorial development in regions;
- formation of hypotheses on the influence of spatial, urban, investment and environmental factors.

2. Materials and methods

Peculiarities of territorial development of land use in regions as a result of generalization of its main directions are determined:

1. High level of spatial support of the regions of Ukraine. The largest share is occupied by agricultural land. The system of coefficients which allow to form spatial maintenance and to specify value of regions in system of spatial relations, considering the region location and population as well as functional-planning, engineering-infrastructure, engineering-geological, historical-cultural, natural-landscape and sanitary-hygienic factors is offered.
2. Low level of territory development in regions, population density. This slows down the territorial development of regional land use. The coefficients characterizing the urban planning value of territories, indicators of the functioning of the construction industry have been determined. They indicate that in recent years there has been an increase in the indices of construction products, the volume of construction work performed. Most of the constructed housing is determined by the low number of stories, which reduces the level of regional land use.
3. Investment indicators that characterize the territorial development of regional land use indicate the absence of areas where the normative monetary valuation of settlements is fully conducted. The Kyiv region has the lowest level of normative monetary valuation of lands and makes up only 25% of the share of settlements in their total number that have a normative monetary valuation. Along with this, the index of capital investments by regions in 2017 as a percentage of the corresponding period of the previous year grew in all regions.
4. The value of environmental indicators indicates a slowdown in waste generation compared to their utilization, incineration and disposal in designated areas or facilities per capita. This positive trend is observed in Volyn, Dnipropetrovsk, Zaporizhia, Kyiv, Luhansk, Odesa, Rivne, Kharkiv, Chernivtsi, Chernihiv regions. In recent years, there has been an increase in capital investment and current environmental expenditures per capita in most regions.
5. The identified trends and results of the analysis of certain indicators characterizing the territorial development of regional land use indicate the need to develop technology for its provision, which is based on information-analytical, spatial and urban planning, taking into account environmental characteristics.
6. The set of spatial, urban, investment and environmental indicators form an evaluative basis for determining the territorial development of regional land use.
7. To make informed decisions in the system of territorial development of land use of regions, it is proposed to determine the level of influence of spatial, urban, investment and environmental factors by building a diagnostic evaluation system of indicators and correlation-regression analysis.

In the context of ensuring the territorial development of the lands in the regions, the peculiarities of the formation and use of industrial lands are important. In particular, there is no “separate” law on industrial land use, given the existence of a wide range of

other legislation. There is no regulation of environmental protection of industrial land use. Industrial lands are associated with the relevant object and their active involvement in market circulation. It should be noted that the norms on industrial land allocation are significantly applied in comparison with the existing European practices.

The use of industrial lands is influenced by the level of their normative monetary value. In particular, for the lands of industrial enterprises, transport and communications organizations, their level of regulatory monetary valuation is only 19.5% of the total area. Normative monetary valuation of lands of industry, transport, communications, energy, defense and other purposes was carried out throughout Ukraine, the average value of which in Ukraine is 1434075 UAH/ha; the largest value – in the Kyiv region – 5508750 UAH/ha, the smallest value – in Luhansk, 360561 UAH/ha (*State Geocadastre, 2018*).

The features and characteristics of the international experience of land use territorial development in regions are defined:

- significant development of lease relations on a long-term basis (Germany, Netherlands, Great Britain, Italy, Israel, China, Bulgaria, Luxembourg, France, Portugal, USA, Denmark, Argentina, Belgium, Spain, Norway, Sweden, Switzerland, Australia, Finland);
- intended purpose of the land plot (Germany, Netherlands, Great Britain, Italy, Israel, Bulgaria, Luxembourg, France, Portugal, USA, Denmark, Argentina, Belgium, Spain, Norway, Sweden, Switzerland, Australia, Finland);
- considering the interests of stakeholders cooperating in the field of land relations (Germany, Netherlands, Great Britain, Italy, Israel, China, Bulgaria, Luxembourg, France, Portugal, USA, Denmark, Argentina, Belgium, Spain, Norway, Sweden, Switzerland, Australia, Finland);
- considering the functional features of the lands (Germany, Netherlands, Great Britain, Italy, Israel, China, Bulgaria, Luxembourg, France, Portugal, USA, Denmark, Argentina, Belgium, Spain, Norway, Sweden, Switzerland, Australia, Finland);
- permanent use of cadastral information (Germany, Netherlands, Great Britain, Italy, Israel, China, Luxembourg, France, Portugal, USA, Denmark, Belgium, Spain, Norway, Sweden, Switzerland, Australia, Finland);
- development of the land administration system (Germany, Netherlands, Great Britain, Italy, Israel, Luxembourg, France, Portugal, USA, Denmark, Belgium, Spain, Norway, Sweden, Switzerland, Finland);
- formation of ecological balance of territories (Germany, Netherlands, Great Britain, Italy, France, Belgium, Spain, Norway, Sweden, Switzerland, Finland).

In addition, at a low or average level, the following factors are considered:

- systematic consideration of agro-climatic features of lands (Great Britain);
- determination of hemorphological features of lands (France);
- systematic formation of directions of land economic evaluation (Great Britain, USA);
- development of 3D cadastre (Netherlands, Israel, Denmark, Norway, Sweden);

- significant influence of public authorities (Netherlands, Great Britain, Israel, China, Australia, Finland);
- high level of involvement of agricultural lands in the sphere of lease relations (Germany, Netherlands, Great Britain, Italy, France, USA, Denmark, Australia).

Thus, in international practices to ensure the territorial development of regional land use the main areas are the formation and development of land relations on a long-term basis, defining the purpose and functional purpose of land, constant consideration of cadastral information with the formation of ecological balance of land use. the system of land administration, where its functions (land ownership, valuation, use, land development) are comprehensively implemented and interact, is of particular importance in the territorial development of regional land use. Geoinformation systems, as a tool for the formation, processing and application of information on the territorial development of regional land use are widely used in modern land administration systems.

It should be noted that in international practice (to ensure the territorial development of regional land use) the importance of systematic accounting of agroclimatic and geomorphological features of lands and the formation of directions for the economic valuation of lands is decreasing. At the same time, the directions for the formation and implementation of a 3D cadastre are being implemented with simultaneous implementing the level of influence of state authorities and attracting agricultural land to the sphere of lease relations. However, the presented directions are being implemented at a mediocre level, which is determined by the peculiarities of the modern development of land relations. At this level, the importance of state institutions in this area is decreasing in the presence of difficulties regarding the formation and implementation of a 3D cadastre. A feature of ensuring the territorial development of land use at the regional level is the creation and implementation of a multipurpose cadastre. A multipurpose cadastre (\mathbb{K}) can formally be represented as a model:

$$\mathbb{K} = \langle \text{DZK, DLK, DVK, DKR, DKT, DKL, DKPL, DKTO, MK, DKRKK, DKS RV, DKVBR, DKMT, DKPTK, NKA V, \Omega} \rangle \quad (1)$$

where DZK, DLK, DVK, DKR, DKT, DKL, DKPL, DKTO, MK, DKRKK, DKS RV, DKVBR, DKMT, DKPTK, NKA V – information support presented in the State cadastre of land, forest, water, flora, fauna, medical world, natural medical resources, territories and objects of the natural reserve fund for urban planning, deposits and manifestations of minerals, storage of radioactive waste, aquatic bioresources, hunting animals in Ukraine, natural resorts, the national inventory of anthropogenic emissions and removals of greenhouse gases, Ω is the set of relations and links between the state cadasters.

The directions for assessing the level of territorial development of land use to ensure their monitoring and decision-making based on the proposed model (1), and systematization of existing theoretical provisions (Hutsulyak, 2002; Dorosh, 2004; Martin, 2011; Tretiak et al., 2016; Kaminetska, 2017) are developed. The areas of assessment of the territorial development level include:

1. Implementation of geofactor analysis aimed at the formation of a complex of spatial (F_1), urban (F_2), investment (F_3) and environmental (F_4) factors influencing the

territorial development of regional land use based on existing scientific and methodological developments and regulations: $F = \langle F_1, F_2, F_3, F_4 \rangle$, construction of a multi-level system of factors: $M = \langle F_1, F_2, F_3, F_4 \rangle$, $\Omega = \{\bar{\omega}_p\}$, $p = \bar{1}, \bar{\psi}$, selection of factors, which have the greatest impact on the territorial development of regional land use by applying the method of expert assessments according to certain criteria.

2. Formation of a multilevel system of indicators by applying quasimetric models of transition from the proposed factors to the corresponding spatial (T_1), urban (T_2), investment (T_3) and environmental (T_4) indicators, considering the values of evaluation coefficients: $M = \langle T_1, T_2, T_3, T_4 \Omega \rangle$, $\Omega = \{\bar{\omega}_p\}$, $p = \bar{1}, \bar{\psi}$.
3. Assessment of the system of spatial, urban, investment and environmental indicators of the third level based on the use of the analytical method and the method of expert assessments: $t_{11i}, t_{21i}, t_{31i}, t_{41i}$.
4. Determination of spatial, urban, investment and environmental indicators of the second level by building mathematical models based on the method of estimating the geometric mean: $t_{1i} = \sqrt[n]{\prod_{l=0}^n t_{1ij}}$, $t_{2i} = \sqrt[n]{\prod_{l=0}^n t_{2ij}}$, $t_{3i} = \sqrt[n]{\prod_{l=0}^n t_{3ij}}$, $t_{4i} = \sqrt[n]{\prod_{l=0}^n t_{4ij}}$.
5. Construction of a mathematical model for determining the integrated spatial, urban, investment and environmental indicators of territorial development of regional land use: $T_1 = t_{1i} \cdot k_{vt1i}$, $T_2 = t_{2i} \cdot k_{vt2i}$, $T_3 = t_{3i} \cdot k_{vt3i}$, $T_4 = t_{4i} \cdot k_{vt4i}$.
6. Determination of weight coefficients characterizing the importance of spatial, urban, investment and environmental indicators in the system of territorial development of regional land use based on the application of the hierarchy analysis method: k_{vt1i} , k_{vt2i} , k_{vt3i} , k_{vt4i} .
7. Determination of integrated spatial, urban-planning, investment, environmental indicators of territorial development of regional land use: T_1, T_2, T_3, T_4 .
8. Assessment of the integral indicator of regional land use: $T = \sqrt[4]{T_1 \cdot T_2 \cdot T_3 \cdot T_4}$.
9. The development and substantiation of the scale of levels of territorial development of regional land use.
10. Interpretation of the obtained results (Mamonov, 2019; 2020).

The mathematical modeling is carried out to create a quantitative basis for decision-making and monitoring based on the formed information and analytical support and the results of assessing the level of territorial development of land use at the regional level. The mathematical modeling is implemented based on the proposed stages:

- formation of information-analytical support of territorial development of regional land use;
- conducting a geofactor analysis to determine the factors influencing the integrated indicator of the level of territorial development of regional land use;
- establishing causal links between factors influencing the territorial development of land use;
- construction of an integrated model of the level of territorial development of regional land use;
- determination of criteria for the adequacy of the developed mathematical model;
- interpretation of the obtained results.

The problems for the implementation of a multipurpose cadastre have been identified:

1. Lack of proper information base of land, including real estate.
2. Low level of application of information technologies using which the modern effective level of land relations management is reached.
3. Low level of efficiency of land relations management.

In this context, to address these issues, it is proposed to take the following measures:

- creation of digital geospatial data on the existing cartographic basis;
- updating of digital geospatial data according to actual space images;
- permanent collection of geospatial attribute data;
- systematic organization of data;
- increasing the efficiency of regional land use;
- to take measures to improve the land valuation system at the regional level.

The current state of the land cadastral system of Ukraine concerning the territorial development of regional land use indicates the presence of a set of problems related to legal contradictions, lack of a unified land management system (subordination to various state institutions), low level of modern geoinformation technologies and implementation land administration systems.

This requires the implementation of transformations following modern trends in the formation of a land administration system using geoinformation systems by implementing a set of actions to create geospatial support and 3D visualization of cadastral information, considering spatial, urban planning, investment and environmental features. As a result of the study of theoretical and methodological provisions, the terminological apparatus of the scientific speciality “Cadastre and land monitoring” has been improved. In particular, the definition of the territorial development of the regional land use was introduced into the functional field. The implementation of a scenario approach to its provision, considering the influence of spatial, urban planning, investment and environmental factors, was proposed. In the context of the definition of territorial development, the definition of land is of particular importance, which is a multidimensional category, the formation of the categorical apparatus of which is based on the application of a systematic approach, regulatory support, considering the spatial, urban planning, environmental and investment characteristics that affect the territorial development of regions.

The definition of land, which is based on a systematic approach made it possible to propose directions for solving institutional problems by creating a single state body for land administration based on the formation and implementation of a land administration system. The definition of land following the current conditions of their use at the regional level requires a transformation of the regulatory framework, especially in terms of defining the land as a component included in real estate, regulating the division of a land plot, its allocation as part of real estate.

An appropriate system to form a hypothesis to determine the influence of factors on the territorial development of land use in regions was formed. Spatial factors consist of territorial, functional, social and political factors, cartographic level factors and factors of geodetic support of regional land use.

Urban factors are formed from factors:

- zonal;
- zonal-planning;
- structural planning;
- planning and restrictive;
- engineering training and equipment of territories;
- transport support;
- historical and architectural;
- functioning of the construction industry in the regions;
- level of development of territories;
- building density;
- the level of application of spatial information in urban planning;
- level of formation of cadastral information in the field of land use of regions for urban planning.

Investment factors are determined by the following factors:

- valuation;
- the level of use of funds;
- property and property rights;
- intellectual;
- stakeholder;
- innovative;
- territorial development of regions;
- attracting foreign investment in the field of land relations in the region;
- public-private partnership;
- the level of implementation of investment activities in the field of regional land use by domestic investors;
- the level of formation of special economic zones to ensure investment in the use of land in the regions;
- the level of provision of a special regime for innovation activity of technological parks in the field of using regional lands;
- implementation of investment projects in the field of regional land use according to the “single window” principle.

Environmental factors consist of factors:

- ecological development;
- the level of waste management;
- the level of rationing and accounting for waste management;
- functional factors to reduce or prevent waste generation;
- the level of notification of a threat or emergencies;
- the level of information about the occurrence and prevention of emergencies;
- the level of the shelter of the population in protective structures of civil protection;
- the level of implementation of evacuation measures;
- the level of engineering protection of territories;
- the level of radiation and chemical protection of the population and territories;
- the level of medical protection;
- ensuring sanitary and epidemic well-being of the population;
- the level of biological protection of the population, animals and plants;
- the level of psychological protection of the population;
- the level of technological safety;
- fire safety level.

3. Results

As a result of the study, a hypothesis about the nonlinearity of the influence of the presented factors on the level of territorial development of regional land use was determined. As a result of modelling the significant influence of the ecological factor on the integrated indicator of territorial development of regional land use is defined. This corresponds to the modern trends that are observed in the system of territorial development of regions, where the main focus is on environmental trends and features, the implementation of environmental programs and the development of legislative support. The presented tendencies determine the development of developed international regional systems. It should be noted that by the value of the coefficient of determination, it can be argued that the growth of the generalizing environmental factor by 70.9% causes a change in the integrated indicator of territorial development of regional land use.

The influence of investment and urban planning factors on the integrated indicator of territorial development of regional land use is determined at a low level. This is due to the following factors:

- the level of investment in the areas of regional land use decreases;
- the volume of financing of activities in the field of land use is reduced or absent;
- the level of land valuation decreases;
- unreasonable development of settlements is carried out;
- the directions of their use change;
- the quality and completeness of urban planning is reduced;
- an imbalance in the directions and features of the territorial use at the regional level identified.

Thus, the impact of investment and urban planning factors by 14.5 and 11.5% cause changes in the integrated indicator of territorial development of regional land use. As a result of modelling, the lowest influence of the spatial factor on the integrated indicator of territorial development of regional land use was established. The spatial factor causes only 2.2% of changes in the integrated indicator of territorial development. This indicates the absence of clear directions and the implementation of systemic measures aimed at the formation of spatial support for the territorial development of land use. Information or geoinformation systems are used at a low level. Cartographic and topographic information is not comprehensively updated. The level of established boundaries of settlements is decreasing. There is no systematic funding for measures to create and improve the spatial provision of land use at the regional level. Regulatory and legal support is not fully implemented in terms of the formation of spatial support for the territorial development of land use.

By characterizing the developed models of the influence of spatial, urban planning, investment and environmental factors on the integral indicator of territorial development of regional land use, it is determined that the first two factors are negatively affecting the integral indicator. This indicates that spatial and urban factors in modern conditions inhibit the territorial development of regional land use. Investment factors only form the potential investment attractiveness of the regional lands, however, measures to increase investment volumes are not being implemented.

The environmental factors provide positive changes in the field of territorial development of land use at the regional level. The level of financing of ecological measures and ecological safety is increasing, the corresponding directions are systematically realized. At the present stage, a moderate (balanced) scenario of territorial development of land use is being implemented. However, this scenario does not provide permanent territorial development, improving the efficiency of land use at the regional level. The moderate scenario only “freezes” the existing situation, does not create conditions for further growth in the efficiency of land use.

In such conditions, it was proposed to develop practical scientifically grounded recommendations for ensuring the territorial development of the regional land use by increasing spatial, urban planning, investment factors. The need for further growth of environmental indicators of territorial development of regional land use has been identified. These measures will increase the integrated indicator – as a general criterion for land use efficiency at the regional level.

4. Conclusions

Thus, the main conceptual provisions for the concept of “territorial development of the regional land use” have been formed. These provisions are characterized by considering the multidimensionality and features of territorial development, directions of changes in spatial, urban planning, investment and environmental factors. This allowed the following:

- to form a theoretical and methodological platform based on the application of a systematic approach;
- to develop a conceptual scheme and highlight the dominant directions for solving the problem of increasing the efficiency of territorial development of regional land use;
- identify problematic aspects that occur in the field of land relations;
- combine the positive directions of existing approaches;
- to develop complex tools for the implementation of modern methods and models.

A multi-level system of factors based on the systematization of existing theoretical and methodological approaches and regulatory support is proposed. This made it possible to build corteges and form information support for spatial, urban planning, investment and environmental factors as well as to form a quantitative basis for determining indicators of territorial development of regional land use. The mathematical modelling of the territorial development of regional land use based on establishing the relationship between the integral indicator of territorial development and generalizing spatial, urban planning, investment and environmental factors by applying the method of correlation-regression analysis was carried out. In contrast to the existing methods, this made it possible to develop recommendations for the growth of the integral indicator of the territorial development of the regional land use.

Author contributions

Conceptualization: K.M.; Methodology development: O.K.; Writing – original draft: K.V.; Writing – review and editing: O.V.

Data availability statement

The raw/processed data required to reproduce these findings cannot be shared at this time as the data also forms part of an ongoing study.

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