Research paper

The recommendations for territorial development of land use in the region

Kostiantyn Mamonov[1], Elena Kondrashenko[2], Yuliia Radzinskaya[3], Maria Myronenko[4]*

Department of Land Administration and Geoinformation Systems,
O.M. Beketov National University of Urban Economy in Kharkiv,
17, Marshala Bazhanova Str., 61002, Kharkiv, Ukraine
[1]e-mail: kostia.mamonov2017@gmail.com, ORCID: http://orcid.org/0000-0002-0797-2609
[2]e-mail: evk034@gmail.com, ORCID: http://orcid.org/0000-0002-9354-1329
[3]e-mail: radzinskayayb@gmail.com, ORCID: http://orcid.org/0000-0002-1661-7975
[4]e-mail: mariamyronenko87@gmail.com, ORCID: http://orcid.org/0000-0002-0266-4463

*Corresponding author: Maria Myronenko

Abstract: In order to ensure the territorial development of land use in the region, there is a need to change the trajectory of spatial and urban planning factors. The ways for implementation of the proposed system measures are defined in the article. For investment and environmental indicators, the integrated indicator of territorial development of land use in the region, depending on their change, is predicted. The article presents the results of forecasting the integrated indicator of land use territorial development in the region based on the growth of systemic investment factors and the results of forecasting the integrated indicator of land use territorial development based on the growth of systemic environmental factors. Practical scientific-based recommendations for ensuring the territorial development of land use in the region by applying the results of its integrated assessment and modeling are proposed. Developed recommendations made it possible to form directions and build the basis for ensuring the territorial development of land use in the region. The development of methodological recommendations for ensuring the territorial development of land use in the region is based on the results of the study of the influence of systematic spatial, urban, investment, and environmental factors on the integrated indicator of land use territorial development.

1. Introduction

The development of methodological recommendations for ensuring the territorial development of land use in the region is based on the results of the study of the influence of systematic spatial, urban, investment and environmental factors on the integrated indicator of land use territorial development (Mamonov et al., 2019; Gosiorowski and Bielecka, 2014; Malashevskyi et al., 2018a,b; Palekh, 2003). The constructed economic and mathematical models made it possible to identify cause and effect relationships between indicators, and geoinformation analysis is to establish monitoring aspects of territorial development of land use in the region (Bober et al., 2016a,b; Calka and Bielecka, 2016; Danylyshyn, 2006a,b). The values of the integrated indicator show that there are no trends in the territorial development of land use in the regions. Therefore, it is necessary to radically change the trajectory of systemic spatial and urban planning factors, which slightly affect the integrated indicator (Mamonov and Rudomakha, 2018; Williamson, 1997; Perovich and Gubar, 2016; Kociuba, 2018; Markowski and Drzazga, 2015).

The purpose of the study is to develop scientific and methodological recommendations for ensuring the territorial development of land use in the regions. To achieve this goal, a set of the following tasks is solved:
- the development and implementation of integrated assessment method for territorial development of land use of regions;
- the identification of factors affecting the territorial development of land use in the regions;
- the determination of the integrated indicator of land use in regions;
- development of economic and mathematical models of the influence of factors on the integral indicator of the land use territorial development;
- the prediction of the integrated indicator of territorial development depending on the growth of spatial, urban, environmental, and investment factors.

2. Materials and methods

It is proposed to apply the method of integrated assessment in the system of territorial development of the use of land in the regions in order to form a quantitative basis for the adoption of reasonable managerial decisions and the development of methodological recommendations. In this context, the relevant directions of its formation and realization are defined, which include: formation of information and analytical support of territorial development of land use of regions; identification of factors affecting territorial development; development and application of local and integral models of factor estimation; the use of analytical and peer review methods to determine the factors of territorial development of land use in the regions; evaluation of the integral indicator of territorial development of land use based on the application of the integrated model; development of scientific and methodological recommendations for ensuring territorial development. For the assessment of territorial development and the application of the appropriate method, the factors that form the basis and information and analytical materials of the integrated assessment are essential.

It is proposed to carry out the following activities:

1. For spatial factors:
   – to create conditions for the realization of directions of regions territorial support increase by stimulating the development of regions, the realization of sectoral, administrative and instrumental directions;
   – to increase the functional indicators based on an increase in the level of land use of residential and public buildings, completeness and quality of land inventory in the process of land management implementation, inclusion of territorial planning, engineering-geological, historical-cultural, natural-landscape, sanitary-hygienic and other conditions in the cadastral information system, balancing of these conditions in the spatial support system, increasing the quality and completeness of information support regarding the status and use of agricultural land in the general land fund by region;
   – to form a spatial information system regarding the status and use of underground real estate;
   – to consider social aspects in the spatial information system of the land use territorial development in the regions;
   – to increase the level of providing the population with housing, preschool institutions, secondary schools, medical institutions (hospitals, clinics, pharmacies), cultural objects (theatres, cinemas, dance halls, clubs, libraries);
   – to consider political factors affecting the spatial support of the territorial development of land use in the region;
   – to improve the material base of local governments and increasing the level of their resource provision;
   – to increase the responsibility of representatives of local authorities, rural, township, city presiding officers to the territorial communities that elected them;
   – to create effective mechanisms to ensure the active participation of territorial communities and local governments in the formation and realization of the state regional policy;
   – to achieve the high functional capacity of human resources of the regions, first of all by the creation of system and technologies of investments attraction for preparation of highly professional managerial personnel;
   – to form the land market infrastructure;
   – to ensure the completeness and quality of cartographic and geodetic support for land use in the regions based on compliance with the standards and regulatory documentation, implementation, and development of advanced technologies and methods for organization of topographic, geodetic and cartographic production;
   – to increase the level of development, implementation, and organization of software, technological and technical support of digital maps and geoinformation systems effective use;
   – to increase the level of geodetic, topographic, aerial surveying and other special activities during other surveys and individual works;

– to ensure the interaction and partnership of regional authorities with state geodetic surveillance authorities in the implementation of topographic, geodetic and cartographic work, as well as the use of state-owned geodetic and cartographic information.

2. For urban planning factors:

– to form the systemic zonal support based on indicators of the level of decisions formation regarding the planning and development of the territory, the level of reflection of the existing building development, engineering and transport infrastructure, as well as the main elements of the planning structure of the territories, the level of determination of the region public area, the level of determination of the region residential area, the level of determination of the region recreational zone, considering of the local conditions when determining the functional zones;

– to form the systemic functional planning support by determining indicators of the implementation level of the building development planning and spatial organization principles, the level of installation of red and building control lines, the level of establishing the functional purpose, determining the regimes and parameters of the building development of one or more land plots, the allocation of territories in accordance with building standards, state standards, and rules, the level of providing urban planning conditions and restrictions (in the case of absence of a territory zoning plan) or clarification of urban planning conditions and restrictions in accordance with the territory zoning plan, the level, and completeness of the architecturally spacious composition formation;

– to form the system of structural and planning support based on indicators of the specific gravity of the residential area;

– to form the systematic planning and restrictive support by applying the level indicators of specific zones of gas contamination, excess noise, electromagnetic radiation, radiation pollution, the level of certain sanitary protection zones of industrial enterprises, cemeteries and other communal facilities, the level of specific zones of sanitary protection of water supply sources, water treatment facilities, the level of protective zones of quarries, dumps, pipelines and other objects, the level of territories and conservation zones of nature reserves, monuments of nature, architecture, history and culture and the regulation zone of buildings and landscapes, which are protected;

– to form the system of urban development support for engineering training and arrangement of territories;

– to form the systemic transport support by establishing a classification of the road network;

– to form the system of historical and cultural support based on indicators of the provision level with monuments of national and local significance of all types according to the classification of cultural heritage;

– to form the systemic support for the functioning of the construction industry in the regions through the application of indicators of the construction products index,

the index of the construction works volume, the standardized value of the accep-
tance rate for housing, the standardized value of the acceptance rate for apartments
in residential buildings at the construction site, the systematic use of spatial infor-
mation in land use urban development in the region based on the formation and
increase of the quality of a single digital topographic basis of the territories;

– to ensure the quality and completeness of the cadastral information formation in
the land use for urban development.

3. For investment factors:
   – to increase the level of investment attractiveness of the land use in the region
     based on ensuring the quality and completeness of information on soil appraisal,
     economic land valuation, standard monetary valuation of land per hectare of the
     region, expert valuation in the system of monetary valuation of lands, the propor-
     tion of the number of settlements, which do not have a normative monetary value
     in their total number;
   – to increase the level of use of funds, property and property rights, which affect the
     formation of investment attractiveness in the system of territorial development of
     land use in the region;
   – to ensure the growth of the directions of formation and implementation of intel-
     lectual capital, which affects the investment attractiveness in the system of land
     use territorial development in the region;
   – to increase the quality of stakeholder relations in the system of territorial develop-
     ment of land use;
   – to form the systemic innovation environment in the territorial development of land
     use in the region based on indicators of the level of formation and implementation
     of innovative programs and projects in the field of land use in the regions;
   – to increase the investment indicators by increasing the standardized index value of
     the physical volume of gross regional product, growth of the standardized agricul-
     tural production index value by region, growth of the standardized value of forest
     products, growth of the standardized value of water production volumes, growth
     of industrial production index;
   – to ensure the attraction of foreign investment in land relations in the region;
   – to develop the public-private partnership, which affects the formation of invest-
     ment in the land use in the region;
   – to ensure the formation of special economic zones to ensure investment in the land
     use of the regions;
   – to ensure the special regime of innovative activity of technology parks in the field
     of land use in regions;
   – to ensure the implementation of land use investment projects in the regions on the
     one-stop-shop principle.

4. For environmental factors:
   – to ensure the ecological development based on the increase of the environment
     protection level or its objects – land, water, subsoil, atmospheric air, flora and

fauna and their levels of pollution, the level of the formed biological diversity and its components, including genetically modified organisms and their interaction with objects of the natural environment, a permanent establishment of the influence of factors, materials, substances, products, energy, physical factors (noise, vibration, electromagnetic radiation, radiation) on the state of the environment and human health, timely identification and reduction of the threat level of occurrence and causes of environmental emergencies, the results of the elimination of these phenomena, implementation of recommendations on measures aimed at reducing their negative impact on natural objects and human health;

– to increase the quality of waste management in the system of territorial development of land use in the region;
– to form a system environment regarding regulation and accounting for waste management;
– to ensure the reduction or prevention of waste generation;
– to increase the level of alert about a threat or emergency;
– to increase the level of information on the occurrence and prevention of emergencies;
– systematic implementation of measures for sheltering the population in civil protection structures;
– to implement a range of evacuation measures by implementing the directions for evacuation planning, identifying safe areas suitable for accommodating the evacuated population and property, organizing notifications to managers of business entities and the population about the start of evacuation, and organizing evacuation management;
– to provide the engineering protection of territories;
– to increase the level of radiation and chemical protection of the population and territories;
– to increase the level of medical protection, ensuring sanitary and epidemic well-being of the population;
– to increase the level of biological protection of the population, animals, and plants by ensuring an increase in the values of factors: the level of timely identification of factors and the organization of biological infection, its localization and elimination; the level of forecasting the extent and consequences of biological contamination, the development and implementation of timely anti-epidemic, preventive, animal disease control, and therapeutic measures, the level of emergency non-specific and specific prophylaxis of biological infection of the population, the level of timely use of personal and collective protective equipment, the level of introduction of restrictive anti-epidemic measures, surveillance and quarantine;
– to ensure the psychological protection of the population in the system of territorial development of land use in the region;
– to ensure the level of psychological safety;
– to increase the level of fire safety in the system of territorial development of land use in the region.

3. Results

In order to ensure the territorial development of the use of land in the region, it is necessary to radically change the trajectory of spatial and urban factors by implementing the proposed systemic measures. Thus, we propose to increase the systematic spatial and urban development indicators by an average of 30%. The integrated indicator of land use territorial development of the region for investment and environmental indicators, depending on their change, has been predicted. The results of integrated indicator changes are presented in Tables 1 and 2.

Table 1. The prediction results of an integrated indicator of the land use territorial development in the region based on the growth of a systemic investment factor, rel. Units (developed by the authors)

No	Regions	Changes in the integrated indicator of the land use territorial development of the region based on the increase of the systemic investment factor by:							
		1%	2%	5%	10%	15%	20%	25%	30%
1	Vinnytsia	−0.002	−0.002	−0.0004	0.001	0.003	0.005	0.007	0.009
2	Volyn	−0.004	−0.004	−0.0025	0.001	0.001	0.003	0.005	0.007
3	Dnipropetrovsk	−0.002	0.001	−0.0002	0.002	0.004	0.006	0.007	0.009
4	Donetsk	0.001	0.002	0.0027	0.005	0.007	0.008	0.010	0.012
5	Zhytomyr	0.0001	0.001	0.0017	0.004	0.005	0.007	0.009	0.011
6	Zakarpattya	0.001	0.001	0.0005	0.002	0.004	0.006	0.008	0.010
7	Zaporizhzhia	0.000	0.001	0.0017	0.004	0.006	0.007	0.009	0.011
8	Ivano-Frankivsk	−0.004	−0.004	−0.0026	0.001	0.001	0.003	0.005	0.007
9	Kyiv	0.002	0.002	0.0036	0.006	0.007	0.009	0.011	0.013
10	Kirovograd	−0.00006	0.000	0.0015	0.003	0.005	0.007	0.009	0.011
11	Lugansk	0.003	0.004	0.0048	0.007	0.009	0.011	0.012	0.014
12	Lviv	−0.003	−0.003	−0.0014	0.001	0.002	0.004	0.006	0.008
13	Mykolaiv	0.00014	0.001	0.0017	0.004	0.005	0.007	0.009	0.011
14	Odesa	0.020	0.021	0.0218	0.024	0.026	0.028	0.029	0.031
15	Poltava	−0.009	−0.009	−0.0078	−0.006	−0.004	−0.002	−0.0001	0.002
16	Rivne	0.0003	0.001	0.0019	0.004	0.006	0.008	0.010	0.011
17	Sumy	0.014	0.014	0.0154	0.017	0.019	0.021	0.023	0.025
18	Ternopil	0.00003	0.000	0.0016	0.003	0.005	0.007	0.009	0.011
19	Kharkiv	−0.004	−0.003	−0.0022	−0.0003	0.002	0.004	0.005	0.007
20	Kherson	−0.002	0.001	−0.0001	0.002	0.004	0.006	0.008	0.009
21	Khmelnytskyi	0.0004	0.001	0.0019	0.004	0.006	0.008	0.010	0.012
22	Cherkasy	0.001	0.002	0.0030	0.005	0.007	0.009	0.011	0.013
23	Chernivtsi	0.001	0.001	0.0006	0.003	0.004	0.006	0.008	0.01
24	Chernihiv	−0.003	−0.002	−0.0013	0.001	0.002	0.004	0.006	0.008

Table 2. The predictive results of the integrated indicator of the land use territorial development of the region based on the growth of the systemic environmental factor, rel. Units (developed by the authors)

No	Regions	Changes in the integrated indicator of the land use territorial development of the region based on the increase of the systemic environmental factor by:					
		1%	2%	5%	10%	15%	20%
1	Vinnytsia	−0.002	0.001	−0.0001	0.002	0.004	0.006
2	Volyn	0.006	0.007	0.0081	0.01	0.012	0.069
3	Dnipropetrovsk	0.002	0.003	0.004	0.006	0.008	0.065
4	Donetsk	−0.00001	0.0004	0.0016	0.004	0.006	0.063
5	Zhytomyr	−0.0003	0.0001	0.0013	0.003	0.005	0.062
6	Zakarpattya	0.001	0.001	0.0024	0.004	0.007	0.063
7	Zaporizhzhia	0.004	0.004	0.0055	0.008	0.01	0.066
8	Ivano-Frankivsk	0.0003	0.001	0.0019	0.004	0.006	0.062
9	Kyiv	0.004	0.004	0.0054	0.007	0.01	0.066
10	Kirovograd	−0.00033	0.0001	0.0013	0.003	0.005	0.062
11	Lugansk	−0.003	−0.002	−0.0009	0.001	0.003	0.060
12	Lviv	0.002	0.002	0.0032	0.005	0.007	0.064
13	Mykolaiv	0.00114	0.002	0.0028	0.005	0.007	0.064
14	Odesa	0.001	0.001	0.0023	0.004	0.006	0.064
15	Poltava	−0.002	0.001	0.0001	0.002	0.004	0.060
16	Rivne	0.0001	0.001	0.0018	0.004	0.006	0.063
17	Sumy	0.001	0.001	0.0026	0.005	0.007	0.064
18	Ternopil	−0.00686	−0.006	−0.0052	−0.003	0.001	0.056
19	Kharkiv	0.0004	0.001	0.002	0.0041	0.006	0.063
20	Kherson	−0.004	−0.003	−0.002	0.000	0.002	0.059
21	Khmelnytskyi	0.0013	0.002	0.0029	0.005	0.007	0.064
22	Cherkasy	0.001	0.002	0.0031	0.005	0.007	0.064
23	Chernivtsi	0.002	0.002	0.0032	0.005	0.007	0.064
24	Chernihiv	−0.002	0.001	0.0001	0.002	0.004	0.061

As a result of predicting the integrated indicator of territorial development of land use in the region, based on the growth of the systemic investment factor, it is necessary to increase it by 30% to ensure territorial development in all regions (see Table 1). This significant growth can be ensured by implementing a set of proposed measures that are of a long-term nature.

The results of predicting the integrated indicator of territorial development of land use in the region based on the increase of the systemic environmental factor indicate the need to increase it by 20% to ensure the growth of the integrated indicator in all

regions of Ukraine (see Table 2). The results of determining the predictive values of the systemic spatial, urban, investment, and environmental indicators in accordance with the established growth rates are presented in Table 3. Based on the study, the predicted values of spatial, urban, investment and environmental factors that ensure the territorial development of land use in the regions are established.

Table 3. The predictive values of the systemic indicators in accordance with the established levels of growth, rel. units

Regions	Predictive values of systemic indicators			
	spatial	urban planning	investment	environmental
Vinnytsia	5.49	5.353	1.893	3.478
Volyn	5.484	5.356	1.651	3.571
Dnipropetrovsk	5.492	5.352	1.765	3.482
Donetsk	5.492	5.35	1.829	3.383
Zhytomyr	5.484	5.359	1.862	3.432
Zakarpattya	5.476	5.351	1.821	3.464
Zaporizhzhia	5.492	5.355	1.728	3.437
Ivano-Frankivsk	5.48	5.356	1.82	3.538
Kyiv	5.486	5.356	1.724	3.377
Kirovograd	5.492	5.35	1.855	3.432
Lugansk	5.49	5.35	1.934	3.337
Lviv	5.486	5.355	1.791	3.516
Mykolaiv	5.492	5.366	1.794	3.416
Odesa	5.442	5.149	1.832	2.848
Poltava	5.49	5.352	1.88	3.69
Rivne	5.482	5.356	1.834	3.416
Sumy	5.44	5.16	1.819	3.031
Ternopil	5.49	5.355	2.062	3.416
Kharkiv	5.492	5.352	1.832	3.541
Kherson	5.49	5.353	1.937	3.454
Khmelnytskyi	5.49	5.353	1.803	3.42
Cherkasy	5.488	5.355	1.804	3.397
Chernivtsi	5.486	5.351	1.793	3.457
Chernihiv	5.488	5.357	1.895	3.515

Based on the developed generalization model and specific systemic indicators, the integrated predictive factor of the territorial development of land use in the region was estimated (Table 4). Table 4 is intermediate, which is used for the results of the compilation of the Table 5.

Table 4. The results of the assessment of the integrated predictive factor of territorial development of land use in the region, rel. units

Regions	Value	Regions	Value	Regions	Value
Vinnytsia	3.729	Kyiv	3.616	Sumy	3.527
Volyn	3.628	Kirovograd	3.698	Ternopil	3.793
Dnipropetrovsk	3.666	Lugansk	3.711	Kharkiv	3.716
Donetsk	3.672	Lviv	3.688	Kherson	3.745
Zhytomyr	3.702	Mykolaiv	3.666	Khmelnytskyi	3.669
Zakarpattya	3.687	Odesa	3.477	Cherkasy	3.664
Zaporizhzhia	3.635	Poltava	3.778	Chernivtsi	3.673
Ivano-Frankivsk	3.708	Rivne	3.683	Chernihiv	3.741

Table 5. The level of increase in the integrated indicator of the territorial development of land use in the region, rel. units

Regions	The absolute value of the integrated indicator	The relative value of the integrated indicator
Vinnytsia	1.905	2.045
Volyn	1.809	1.994
Dnipropetrovsk	1.846	2.015
Donetsk	1.853	2.019
Zhytomyr	1.881	2.033
Zakarpattya	1.866	2.025
Zaporizhzhia	1.818	2.001
Ivano-Frankivsk	1.884	2.033
Kyiv	1.801	1.992
Kirovograd	1.877	2.031
Lugansk	1.891	2.039
Lviv	1.866	2.024
Mykolaiv	1.847	2.015
Odesa	1.677	1.932
Poltava	1.947	2.064
Rivne	1.863	2.024
Sumy	1.721	1.953
Ternopil	1.966	2.076
Kharkiv	1.892	2.037
Kherson	1.920	2.052
Khmelnytskyi	1.850	2.017
Cherkasy	1.846	2.015
Chernivtsi	1.853	2.018
Chernihiv	1.916	2.050

The level of increase in the predictive value of the integrated indicator of the territorial development of land use in the region is presented in Table 5.

The growth of spatial, urban, investment, and environmental factors provides a slight increase in the integral indicator of territorial development of land use in the regions. Thus, the predicted values of the integrated factor of the territorial development of land use in the region and its growth trends indicate the possibility of implementing a growth scenario. However, it is necessary to verify another essential condition – the level of influence of systemic spatial, urban, investment and environmental factors. This verification is carried out based on the mathematical modeling of the influence of the systemic indicators predicted values on the predicted integrated factor. Mathematical models of the influence of forecast values of systemic spatial, urban, investment and environmental indicators on the integrated forecast factor of the territorial development of land use in the region and the values of determination coefficients are presented in Table 6.

Table 6. The influence of systemic indicators on the integrated forecast factor of the land use territorial development in the region and the values of determination coefficients, rel. units

Systemic indicators	Model characterizing the influence of a system indicator on an integrated factor	Coefficient of determination
Spatial	$y = 3.486x - 15.44$	$R^2 = 0.544$
Urban planning	$y = 0.953x - 1.409$	$R^2 = 0.602$
Investment	$y = 0.483x + 2.793$	$R^2 = 0.32$
Ecological	$y = 0.331x + 2.548$	$R^2 = 0.634$

The study found a positive impact of systematic spatial, urban, investment, environmental indicators on the integrated factor of territorial development of land use in the region. The values of the determination coefficients indicate an increase in the stability of the developed mathematical models (Table 6). Based on the obtained predictive values of the integrated indicator of the land use territorial development in the region and its existing data, a 3D geoinformation model for monitoring the status and predictive trends of the territorial development of land use in the regions is constructed.

4. Conclusions

As a result of the study, it was proposed to apply the method of mathematical modeling based on correlation and regression analysis, which provided forecasting of the integral indicator of territorial development of land use in the regions depending on the growth of spatial, urban, environmental and investment factors. Within the framework of mathematical modeling, models of the influence of factors on the integral indicator with the determination of the correlation coefficient and determination are constructed.

The mathematical modeling of the land use territorial development in the region has been improved based on establishing a relationship between the integrated indicator

of territorial development and generalizing spatial, urban, investment and environmental factors by applying the method of correlation and regression analysis. In contrast to the existing methods, the study made it possible to develop recommendations for increasing the integrated indicator of territorial development of land use in the region. Practical scientific-based recommendations for ensuring the territorial development of land use in the region by applying the results of its integrated assessment and modeling are proposed. This made it possible to ensure the formation of contours of the territorial development of land use in the region based on the growth scenario.

Acknowledgments

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