

*Research paper*

## Geoinformation analysis of the united territorial communities land use

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**Abstract:** The value of the integrated indicator of the united territorial communities land use is determined. An assessment of the integral indicator was carried out and directions for the development of methodological recommendations to improve the efficiency of land use of the united territorial communities were identified. A feature of the use of GIS for analysis and visualization of integrated indicators of land use of the united territorial communities is the development of a geoinformation analysis scheme. The developed scheme of geoinformation systems using for modelling, evaluation, and analysis of integrated indicators of the united territorial communities land use gives the opportunity to form information and analytical support of monitoring based on geospatial information and to create the basis for increasing the united territorial communities land use. The sequence obtained in the article ensures the monitoring of changes in the spatial characteristics of the lands of the united territorial communities in the region. The results of determining the integral indicators of land use of the united territorial communities obtained in the article make it possible to carry out geoinformation analysis and build a GIS map of the land use. The developed GIS map allows the formation of information and analytical monitoring support based on the values of integrated indicators of land use. Also, the data of the presented map allow to predict the directions of land use of the united territorial communities, to compare them by territorial features and features depending on changes of system spatial, urban, investment and ecological factors.

**Keywords:** integrated indicator, united territorial communities, geoinformation analysis



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## 1. Introduction

Modern conditions are characterized by the instability of the functioning of national and regional institutions, the flexibility of their forms that combine the appearance of new and preservation of old elements. This fully concerns the formation of united territorial communities (UTC) immanent to the decentralization reforms implemented in Ukraine. Their development is characterized by the formation of new relations between the state and local communities, where the latter has significant powers, including in the use of land. The Law of Ukraine “On Voluntary Association of Territorial Communities” No. 157-VIII edition of 01.01.2019 defines the territorial features of the formation and use of UTC lands. By the Decree of the Cabinet of Ministers of Ukraine “Issues of the transfer of agricultural land of state ownership to the communal property of the united territorial communities” dated January 31, 2018 No. 60-p, the procedure for the transfer of agricultural land of state ownership to the communal property of the united territorial communities is defined. According to the Ukrainian Center for Public Data, the number of united territorial communities in 2015–2018 increased by more than 4 times. However, the processes of UTC formation carry the legacy of a hierarchically organized structure, where the central government bodies exercise significant influence, imbalances, and contradictions between regional institutions and united territorial communities are determined. In such conditions, the urgent task is to increase the efficiency of UTC land use based on the formation and implementation of information and analytical support for their monitoring.

## 2. Materials and methods

For the implementation of geoinformation analysis, the land use indicators of the united territorial communities were evaluated. It is proved that at the present stage of land relations development in Ukraine the importance of directions of formation and use of land of UTC is increasing. In this process, it should be noted the increase in the number of UTC, the provision of structural institutional changes, the directions of project implementation (the largest number of them are in the sphere of housing and communal services, education, health care, social security, and other spheres), financial support. At the same time, the number of projects implemented in the sphere of formation and realization of land relations have not been established. This reduces the land use efficiency of UTC and requires research on the formation of information support for monitoring the UTC land use.

The population density of UTC in the regions of Ukraine as a result of the assessment of spatial support for the UTC land use is determined. However, the value of this indicator remains low, which requires ensuring the prevailing trends of population growth in comparison with the increase in their areas. It has been determined that spatial support indicators form the basis for assessing the level of the UTC land use communities and allow to develop a quantitative basis for land use monitoring. Geoinformation analysis

is aimed at creating a monitoring system of the UTC land use. The specific features of formation and monitoring of the UTC land use are characterized by:

- directions of land development;
- lands of enterprises;
- rights and obligations of landowners and tenants using the land;
- establishment of easements for the implementation of land reclamation measures, rights of owners, users of the land plot on which the land easement is established;
- directions of land inventory;
- the use of unallocated and unclaimed land;
- disposal of the lands that remain in the collective ownership of the collective agricultural enterprise, agricultural cooperative, agricultural joint-stock company;
- acquisition and sale of lease rights to land plots located in the array of agricultural land;
- formation of rights to use other land plots;
- carrying out an inventory of an array of agricultural lands;
- formation of technical documentation for soil testing.

To conduct the research, a theoretical and methodological platform based on the developments (Bober et al., 2016a,b; Calka and Bielecka, 2016; Danylyshyn, 2008; Enemark, 1998; Gasiorowski and Bielecka, 2014; Horbatiuk and Klymenko, 2007; Lykhohrud, 2000; Mamonov et al., 2016a,b; Shypulin, 2010; Ukrainian Center for Social Data, 2018; Van Oosterom, 2013; Radzinska, 2017; Shterndok, 2017; Maleta and Mościcka, 2018; Sidorenko et al., 2018; Malashevskiy et al., 2018) was formed. In European local government practices, particular attention is focused on land use information tools at regional and municipal level. Special attention is paid to the formation of information-analytical and spatial support, monitoring through the use of geoinformation systems and technologies. An example of effective use of this modern toolkit is Germany, Sweden, and France.

Aleksander Noworól (2014) in his work presents the mentioned project, and identifies the role of partnerships as a key tool of urban policy. The specific organizational instruments of this policy, roles of the managing body the so-called Integrated Territorial Investments in large urban centres are suggested. In order to stimulate the development of networks of smaller cities or towns which are losing their previous functions the creation of multi-centre and single-centre urban partnerships was proposed.

The methodological aim, in turn, is to present the use of the ArcGIS location-allocation tool for the purposes of delimitation processes as exemplified by administrative boundaries in Poland. In (Borowska-Stefańska and Wiśniewski, 2017) the use of the ArcGIS site allocation tool for demarcation purposes, as exemplified by administrative boundaries in Poland is presented.

In Lithuania, as in many European countries, territorial planning is a key measure for the the landscape formation and changing its elements (Juknelienė et al., 2017). With the help of the documents of the territorial planning, the authorities have the opportunity to regulate the layout of long-term sustainable elements of the landscape and the sustainable development of the territories. However, in comparison with other EU countries, the territorial planning system operating in Lithuania has peculiarities with the former

countries of the legal regulation of the Soviet bloc. The system did not provide a consistent and sustainable mechanism for territorial development: there were no measures to manage the processes of development of residential areas and implement decisions on territorial planning for the creation of a harmonious functional spatial system. The assessment carried out summarizes the processes of landscape formation in territorial planning, make new opportunities for more accurate forecasting of the results of the current landscape planning process, and highlights the legal and sustainable elements of optimization of the territorial planning system. In the work it is noted that one of the most important tasks of territorial planning was and remains a balance of relations between the documents of territorial planning in the formation of cultural landscape to ensure the rational distribution of the land fund, combining different activities, as well as often different interests of land users and the public.

The new state intervention policy, including development policy, requires serious reform as well as structural and institutional adaptation to the new conditions. The paper (Markowski, 2013) presents a set of recommendations and directions of activities addressed to the concerned state institutions and responsible for the planning system. The ongoing debate on cohesion policy, and in particular the nature of territorial cohesion, provide an opportunity to create a new policy and planning model. However, the current European debate mixes the concepts of spatial cohesion and territorial cohesion and views them as synonymous. This leads to many misunderstandings. The concept of integrated planning, the dilemma of delimitation of functional areas in the policy of territorial cohesion and functional territories as the subject of regional policy are analyzed. It should be noted that the functional area-oriented approach provides a greater probability of more effective use of support tools and will be more efficiently used to achieve development policy goals.

In order to form informational and analytical support for monitoring land use in the region of the UTC by applying the obtained values of integrated indicators and presenting its data by region, it is proposed to carry out a geoinformation analysis of the UTC land use. Moreover, the method of integrated assessment of the UTC land use is used, which is a complex process, which includes a system of interrelated stages:

- the formation of information-analytical and spatial support of the level and directions of land use of the UTC;
- definition and characterization of methods and models used for an integrated assessment of land use of the UTC;
- the formation of integrated assessment technology;
- determination of indicators used for an integrated assessment of the UTC land use;
- the implementation of the selection of the indicators by the method of neural networks;
- the formation of a two-level system of indicators;
- assessment of indicators of the second level by analytical methods and expert assessment methods;
- assessment of generalized spatial, urban planning, investment, environmental indicators (level 1) using the geometric mean method;

- development of a model for assessing the integrated indicator of the UTC land use;
- assessment of weight coefficients characterizing the degree of influence of spatial, urban, investment and environmental indicators on the generalizing criterion for the use of lands of the UTC;
- determination of the integrated indicator of land use of the UTC;
- development of guidelines for improving the UTC land use;
- the formation of a geoinformation map of the UTC land use.

An important stage in the development of the method is the determination of the integrated indicator of the UTC land use, which forms an informational and quantitative basis for the development of appropriate methodological recommendations. In addition, at this stage, it is proposed to apply the scale of the integrated indicator in accordance with the level of the UTC land use (Table 1).

Table 1. The scale of the integrated indicator in accordance with the level of land use of the united territorial communities

The value of the integrated indicator	The level of land use of the united territorial communities
1	2
0	The lack of directions for the formation and use of land of the UTC. It is determined by regions where there are no united territorial communities, there are no relations between governing bodies of various levels with the local community. At the local level, documentation on the regulation of land relations of the united territorial communities has not been developed.
1	The low level of developed directions of land formation and use of the UTC. It is determined by the regions where the united territorial communities are created at a low level. Relations between the governing bodies of various levels with the local community are slowly being realized. At the local level, separate documentation on the regulation of land relations of the UTC has been developed, but it has an “outdated” character, and inventory of the land and property complex is not conducted.
2	The directions for the formation and use of land of the UTC have been developed. It is determined by the regions where the UTC are created, however, the implementation of the relevant areas does not correspond to modern approaches to the development of united territorial communities in the state. Relations between governing bodies at various levels with the local community are being implemented. At the local level, separate documentation on the regulation of land relations of the UTC has been developed; most of it has an “outdated” character, however, an inventory of the land property complex is conducted to update it.
3	The directions for the formation and use of land of the united territorial communities are being implemented. It is determined by the regions where the UTC are created and the corresponding development programs are implemented. Relations between governing bodies at various levels with the local community are being implemented. At the local level, documentation on the regulation of land relations of the UTC has been developed; most of it has an “outdated” character, however, an inventory of the land property complex is conducted, some of its types are being updated.

1	2
4	<p>The directions for the formation and use of land of the UTC are systematically implemented. It is determined by the regions where the united territorial communities are created and the corresponding development programs are being implemented. Relations between governing bodies of various levels with the local community are being implemented and is determined by a certain level of cooperation. At the local level, documentation on the regulation of land relations of the UTC has been developed, and its non-systemic updating is being carried out.</p>
5	<p>The directions of the formation and use of land of the UTC are permanently implemented. The corresponding development programs are being implemented. The corresponding managerial structure is built to ensure its functioning. Relations between governing bodies at various levels with the local community, the principles of partnership and interaction between them are being implemented. At the local level, documentation on the regulation of land relations of the UTC has been developed, and its non-systemic updating is being carried out. The permanent work on the inventory of the land property complex is carried out.</p>
6	<p>The directions of the formation and use of land of the UTC are systematically implemented. The corresponding development programs are carried out in them. An appropriate management structure is built to ensure its functioning. Relations between governing bodies at various levels with the local community are carried out. The principles of partnership and interaction between them are implemented. At the local level, documentation on the regulation of land relations of the UTC has been developed, and its systemic updating is being carried out. The permanent work on the inventory of the land property complex is carried out.</p>
7	<p>The directions of the formation and use of land of the UTC are systematically implemented. This leads to increased efficiency in the use of certain areas of land use. The corresponding development programs are carried out in them. An appropriate management structure is built to ensure its functioning. Relations between governing bodies at various levels with the local community are carried out. The principles of partnership and interaction between them are implemented. At the local level, documentation on the regulation of land relations of the UTC has been developed, and its systemic updating is being carried out. The permanent work on the inventory of the land property complex is carried out. The certain areas of the implementation of development programs for the UTC and land relations are funded.</p>
8	<p>The directions of the formation and use of land of the UTC are systematically implemented. This leads to increased efficiency in the use of land use. The corresponding development programs are carried out in them. An appropriate management structure is built to ensure its functioning. Relations between governing bodies at various levels with the local community are carried out. The principles of partnership and interaction between them are implemented. At the local level, documentation on the regulation of land relations of the UTC has been developed, and its systemic updating is being carried out. The permanent work on the inventory of the land property complex is carried out. The certain areas of the implementation of development programs for the UTC communities and land relations are funded.</p>
9	<p>The high level of implementation of areas of land formation and use. This leads to increased efficiency in the use of land use. The corresponding development programs are carried out in them. An appropriate management structure is built to ensure its functioning. Relations between governing bodies at various levels with the local community are carried out. The principles of partnership and interaction between them are implemented. At the local level, documentation on the regulation of land relations of the united territorial communities has been developed, and its systemic updating is being carried out. The permanent work on the inventory of the land property complex is carried out. The implementation of development programs for the UTC and land relations is funded.</p>

1	2
10 and higher	The absolute level of implementation of the directions of land formation and use. This leads to the development of land relations. An appropriate management structure is built to ensure its functioning. Relations between governing bodies at various levels with the local community are carried out. The principles of partnership and interaction between them are implemented. At the local level, documentation on the regulation of land relations of the UTC has been developed, and its systemic updating is being carried out. The permanent work on the inventory of the land property complex is carried out. Areas of implementation of development programs of the UTC and land relations are constantly funded. Modern tools and technologies of land relations management of the UTC are applied. The information and geoinformation system of formation and use of land of the UTC is built and used.

The proposed scale is based on the development of T. Saati. The results of the data are presented in the Table 2.

Table 2. The assessment results of the generalization and integrated indicators of land use of the united territorial communities, relative units

Regions	The value of generalization indicators				The value of the integrated indicator $O$
	Spatial $O_s$	Urban planning $O_u$	Investment $O_i$	Ecological $O_e$	
1	2	3	4	5	6
Vinnytsia	0.128	0.637	0.315	0.224	1.304
Volyn	0.155	0.637	0.315	0.227	1.334
Dnipropetrovsk	0.120	0.637	0.315	0.212	1.284
Donetsk	0.071	0.637	0.315	0.197	1.220
Zhytomyr	0.200	0.637	0.315	0.187	1.339
Zakarpattia	0.058	0.637	0.315	0.197	1.207
Zaporizhzhia	0.146	0.637	0.315	0.173	1.271
Ivano-Frankivsk	0.119	0.637	0.315	0.256	1.328
Kyiv	0.098	0.637	0.315	0.096	1.146
Kirovohrad	0.086	0.637	0.315	0.158	1.196
Lugansk	0.084	0.637	0.315	0.064	1.100
Lviv	0.106	0.637	0.315	0.239	1.297
Mykolaiv	0.153	0.637	0.315	0.173	1.278
Odesa	0.109	0.637	0.315	0.297	1.358
Poltava	0.118	0.637	0.315	0.299	1.369
Rivne	0.130	0.637	0.315	0.147	1.229
Sumy	0.169	0.637	0.315	0.195	1.317
Ternopil	0.172	0.637	0.315	0.189	1.314
Kherson	0.088	0.637	0.315	0.126	1.166

1	2	3	4	5	6
Kharkiv	0.136	0.637	0.315	0.210	1.298
Khmelnitsky	0.157	0.637	0.315	0.168	1.277
Cherkasy	0.121	0.637	0.315	0.150	1.223
Chernivtsi	0.137	0.637	0.315	0.213	1.303
Chernihiv	0.166	0.637	0.315	0.225	1.344

The value of the obtained integrated indicator of land use by the UTC by region is within 1–2 on the scale of the integrated indicator in accordance with the land use level. This indicates that:

- most of the factors of spatial, urban planning, investment, and environmental trends are not considered;
- the level of formation and use of lands of the UTC is low;
- the implementation of relationships between governing bodies at various levels with the local community is slow;
- the development of separate documentation at the local level, or the use of outdated ones.

In such circumstances, there is a need for the development of methodological recommendations to improve the efficiency of land use of the UTC (Mamonov et al., 2016a,b; Radzinska, 2017).

### 3. Results

Thus, the value of the integrated indicator of land use of the UTC was determined, which made it possible to assess it and identify areas for the development of methodological recommendations to improve the efficiency of the UTC land use.

The result of the analysis is a GIS map with the values of the integrated indicators of the UTC land use by regions, which systematically displays the regional characteristics of the UTC land use, taking into account the influence of spatial, urban, investment and environmental factors. The use of integrated indicators was carried out considering restrictions on the classification criteria. At the same time, one of the conditions for the analysis is the construction of an algorithm for distributing data of integrated indicators by regions and determining the geodatabase structure.

A feature of GIS application for analysis and visualization of integrated indicators of the UTC land use is the development of a geoinformation analysis scheme (Figure 1). At the same time, a mandatory component of the scheme is a modelling of the influence of generalization indicators groups, which form an integrated criterion for the UTC land use.

According to the developed scheme, the use of geoinformation systems for modelling, evaluation, and analysis of integrated indicators of the UTC land use makes it



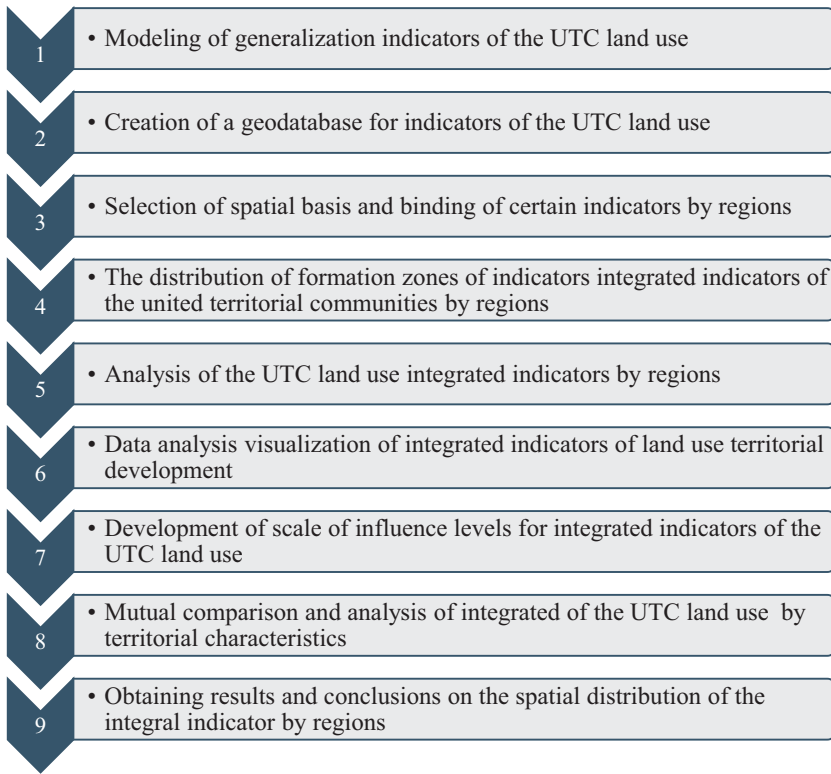


Fig. 1. Scheme of the implementation of geoinformation analysis on the united territorial communities land use

possible to form an information and analytical support for monitoring based on geospatial information and to create a basis for increasing of the UTC land use. The resulting sequence will ensure monitoring of changes in the spatial characteristics of the lands of the UTC in the region.

#### 4. Discussions

Thus, the results of determining the integral indicators of the UTC land use make it possible to carry out geoinformation analysis and build a GIS map of the UTC land use (Figure 2).

The data of the presented map allow forecasting the directions of the UTC land use, comparing them according to the territorial basis and features, depending on changes of systemic spatial, urban, investment and environmental factors.

The scale of the integral indicator level of the UTC land use  $O$ , which is determined by the values of the corresponding integral indicator by regions of Ukraine, was developed (Figure 2). It was found that the majority of united territorial commu-

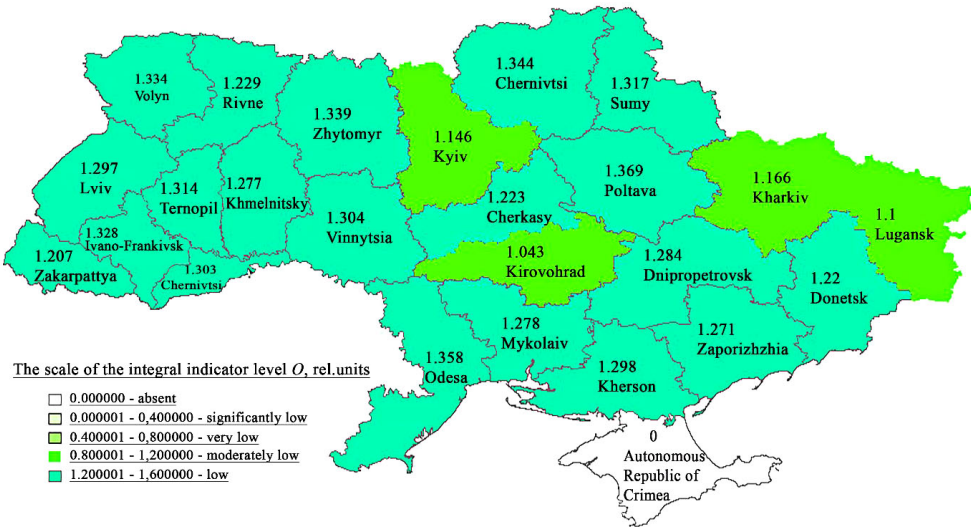


Fig. 2. A GIS map of the united territorial communities land use by regions

nities in the regions have a low level of integrated land use indicator: Vinnytsia (1.304), Volyn (1.334), Dnipropetrovsk (1.284), Donetsk (1.22), Zhytomyr (1.339), Zakarpattia (1.207), Zaporizhzhia (1.271), Ivano-Frankivsk (1.328), Lviv (1.297), Mykolaiv (1.278), Odesa (1.358), Poltava (1.369), Rivne (1.229), Sumy (1.317), Ternopil (1.314), Kherson (1.298), Khmelnytsky (1.277), Cherkasy (1.223), Chernivtsi (1.303), and Chernihiv (1.334). The functioning of the united territorial communities in the regions: Kyiv (1.146), Kharkiv (1.166), Lugansk (1.1) and Kirovohrad (1.043) is characterized by a moderately low level of the indicator.

Thus, based on a GIS analysis of the UTC land use, it should be noted that most regions have a low level of integrated land use. This indicates the inhibition of the territorial development of land use, the unbalanced and multidirectional nature of the influence of spatial, urban, investment and environmental factors. The low level of spatial support for monitoring of the UTC land use, the lack of systematic actions for the implementation of urban planning and investment areas were determined. In recent years, there have been positive shifts in the environmental support of the UTC land use. However, environmental measures are non-systematic. Thus, to ensure territorial development, it is proposed to implement methodological recommendations for improving the efficiency of the UTC land use in the context of systematic spatial, urban, investment and environmental factors based on the formed information and analytical support for monitoring and use of modern geoinformation tools. In the context of information and analytical support, the definition of the monitoring concept of the UTC land use is proposed, which is based on a systematic approach and takes into account spatial, urban, environmental and investment factors, which allowed to develop a theoretical and methodological basis for improving land use efficiency and ensuring appropriate control and application of modern geoinformation tools.

## 5. Conclusions

As a result of the study, a set of tools for geoinformation analysis of the united territorial communities land use was implemented, which, unlike the existing ones, makes it possible to visualize geospatial information and create a monitoring basis for increasing of land use. The method of integral estimation of the UTC land use for increasing the efficiency of monitoring procedures application, based on the integrated approach, information and analytical support, methodical analytical procedure, with the possibility of applying modern methods and models, is proposed. The system of information and analytical support of integrated assessment of the UTC land use has been formed on the basis of changes in spatial, urban, investment and environmental factors, as well as data on the use of geoinformation systems, which allows to form a complex of monitoring actions, to ensure the quality and completeness of technical information used in the system of land use.

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