

Research paper

Geoinformation analysis of the united territorial communities land use

Andrii Evdokimov¹, Kostiantyn Dolia², Artur Rudomakha³, Elena Palamar^{4*}

O.M. Beketov National University of Urban Economy in Kharkiv, Ukraine

¹e-mail: akim050776@gmail.com, ORCID: <http://orcid.org/0000-0002-7538-8922>

²e-mail: c.dolya@ukr.net, ORCID: <http://orcid.org/0000-0002-4693-9158>

³e-mail: rudomahaartur@ukr.net, ORCID: <http://orcid.org/0000-0003-2904-6240>

⁴Kryvyi Rih National University

11 Vitaliy Matusevych St., Kryvyi Rih, 50027, Ukraine

e-mail: palamar1alena@gmail.com, ORCID: <http://orcid.org/0000-0002-3550-6277>

*Corresponding author: Elena Palamar

Received: 26 September / Accepted: 5 November 2019

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



© 2019 by the Author(s). Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY-NC) license (<http://creativecommons.org/licenses/by/4.0/>).

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;

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

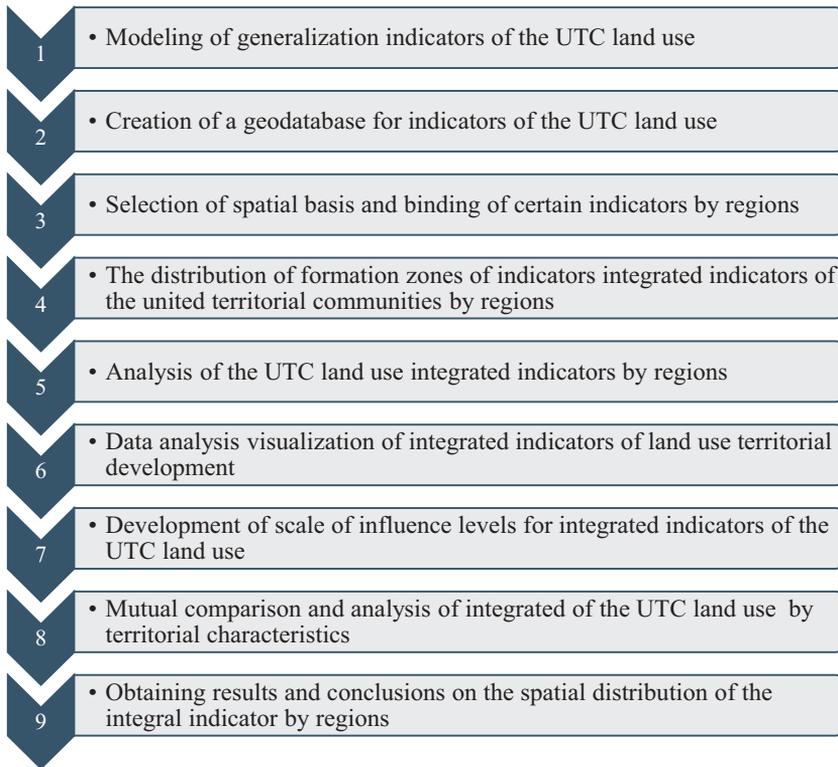


Fig. 1. Scheme of the implementation of geoinformation analysis on the united territorial communities land use

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-

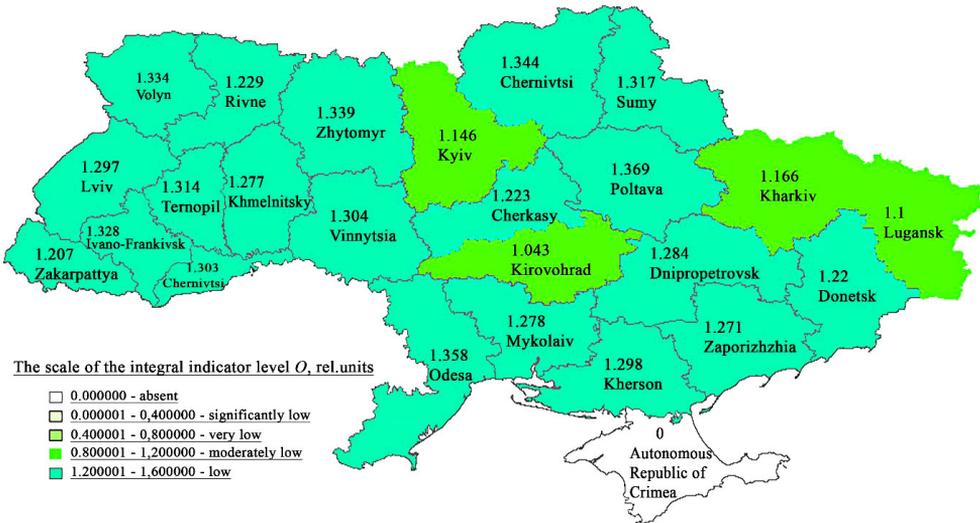


Fig. 2. A GIS map of the united territorial communities land use by regions

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), Zakarpattya (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.

Acknowledgments

The research has no external funds.

References

- Bober, A., Calka, B. and Bielecka, E. (2016a). Synthetic Landscape Differentiation Index a Tool for Spatial Planning. *2016 Baltic Geodetic Congress (BGC Geomatics)*, Gdansk, Poland, 2016, pp. 234–238. DOI: [10.1109/BGC.Geomatics.2016.49](https://doi.org/10.1109/BGC.Geomatics.2016.49).
- Bober, A., Calka, B., and Bielecka, E. (2016b). Application of state survey and mapping resources for selecting sites suitable for solar farms. *Informatics, Geoinformatics and Remote Sensing Conference Proceedings, SGEM 2016, vol. I. Book Series: International Multidisciplinary Scientific GeoConference – SGEM*, pp. 593–600.
- Borowska-Stefańska, M. and Wiśniewski, S. (2017). The use of network analysis in the process of delimitation as exemplified by the administrative division of Poland, *Geodesy and Cartography*, 66(2), 155–170; DOI: [10.1515/geocart-2017-0019](https://doi.org/10.1515/geocart-2017-0019).
- Calka, B. and Bielecka, E. (2016). The Application of Geoinformation Theory in Housing Mass Appraisal. *2016 Baltic Geodetic Congress (BGC Geomatics)*, Gdansk, Poland, 2016, pp. 239–243. DOI: [10.1109/BGC.Geomatics.2016.50](https://doi.org/10.1109/BGC.Geomatics.2016.50).
- Danylyshyn, V.M. (2008). *Ekolohichna skladova polityky staloho rozvytku*. Donetsk: Yuhovostok. Ltd.
- Enemark, S. (1998). Updating digital cadastral maps: the Danish experience. *Proceedings of the FIG XXI International Congress. Commission 7: Cadastre and Land Management. July 19–25*. Brighton: Jessica Kingsley Publishers, pp. 426–437.
- Gasiorowski, J. and Bielecka, E. (2014). Land fragmentation analysis using morphometric parameters. *Conference: 9th International Conference on Environmental Engineering (ICEE)*. Vilnius, Lithuania, May 22–23, 2014. *9th International Conference Environmental Engineering (9th ICEE) – Selected Papers*.
- Horbatiuk, V.M. and Klymenko, K.V. (2007). Organizational and technological features to monitor land at the regional level. *Geodesy, Cartography and Aerial Photography*, 69, 150–156.

- Juknelienė, D., Valčiukienė, J. and Atkocevičienė, V. (2017). Assessment of regulation of legal relations of territorial planning: A case study in Lithuania. *Land Use Policy*, 67, 65–72. DOI: [10.1016/j.landusepol.2017.05.019](https://doi.org/10.1016/j.landusepol.2017.05.019).
- Lykhohrud, M.H. (2000). Struktura y osoblyvosti formuvannia kadastrovoho nomera zemelnoi dilianky ta inshoi nerukhomosti [Structure and features of formation of cadastral number of land plot and another real estate], *Zemlevporiadnyi visnyk*, 4, 64–68.
- Malashevskiy, M., Kuzin, N., Sidorenko, V., Palamar, A. and Malanchuk, M. (2018). Calculation and justification of land tax and rent for the land used for the parking of vehicles on public lands, *Geodesy and Cartography*, 67(1), 87–97; DOI: [10.24425/118700](https://doi.org/10.24425/118700).
- Maleta, M. and Mościcka, A. (2018). Selection and significance evaluation of agricultural parcels determinants. *Geodesy and Cartography* 67 (2), 239–253; DOI: [10.24425/gac.2018.125473](https://doi.org/10.24425/gac.2018.125473).
- Mamonov, K. (2016a). Application of GIS Systems During the Land Management of Cities of Ukraine. *O.M. Beketov National University of Urban Economy in Kharkiv*, 130, 86–91.
- Mamonov, K. (2016b). Application of WEB geoinformation systems for the distribution and use of land. *O.M. Beketov National University of Urban Economy in Kharkiv*, 132, 132–135.
- Mamonov, K.A., Nesterenko, S.G. and Vyatkin, K.I. (2016). HIS – zabezpechennya pry ratsionalnomu vykorystanni zemelnykh resursiv miskoyi zabudovy [GIS – ensuring rational use of land resources of urban development]. *Scientific Bulletin of Civil Engineering*, 86(4), 283–286.
- Markowski, T. (2013). Territorial dimension of integrated development policy – expectations and challenges concerning planning and institutional systems. *Studia Regionalia* 35, 51–64.
- Noworól, A. (2014). Territorial partnerships as an instrument of urban policy. *Biuletyn KPZK*, 253, 11–28.
- Shypulin, V.D. (2010). Osnovni pryntsyipy heoinformatsiinykh system. Kharkiv: KhNAMH.
- Shterndok, E.S. (2017). Analiz stanu ta zmin, shcho vidbuvayutsya u sferi formuvannya, rozpodilu ta vykorystannya zemel m. Kharkova [Analysis of the condition and changes in the sphere formation, distribution and use land of Kharkov]. *Region – 2017: Socio-geographical Aspects: Materials of International scientific-practical conference*, Kharkiv, Ukraine, April 20–21, KhNU named after V.N. Karazin, pp. 135–136.
- Sidorenko, V., Malashevskiy, M., Kuzin, N., Palamar, A. and Malanchuk, M. (2018). Studying the ways of effective taxation of objects of underground commercial space, *Geodesy and Cartography*, 67 (1), 71–85. DOI: [10.24425/118695](https://doi.org/10.24425/118695).
- Radzinska, Yu.B. (2017). Theoretical approaches to definition of investment attractiveness of land in cities. *Urban management of cities. Series Technical Sciences and Architecture*, 137, 25–30.
- Van Oosterom, P. (2013). Research and development in 3D cadastres, *Computers. Environment and Urban Systems*, 40, 1–6; DOI: [10.1016/j.compenvurbysys.2013.01.002](https://doi.org/10.1016/j.compenvurbysys.2013.01.002).
- Ukrainian Center for Social Data (15 April 2018). Dynamika ovednannya terytorialnykh hromad Ukrayiny (2015–2018) [The dynamics of the unification of territorial communities of Ukraine (2015–2018)]. <http://socialdata.org.ua/dynamika-obiednannya-teritorialnikh-g/>.