LATVIA UNIVERSITY OF LIFE SCIENCES AND TECHNOLOGIES

UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN (Poland)

VYTAUTAS MAGNUS UNIVERSITY (Lithuania)

BALTIC SURVEYING

INTERNATIONAL SCIENTIFIC JOURNAL

2021

Volume 15

ISSN 2255 – 999X (online)

ISSN 2255 – 999X (online)

DOI: 10.22616/j.balticsurveying.2021.15

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INTERNATIONAL SCIENTIFIC JOURNAL

2021 / 2

Volume 15

Published since 2014

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Journal is jointly issued by consortium of:

- Department of Land Management and Geodesy of Latvia University of Life Sciences and Technologies, Latvia
- Department of Spatial Analysis and Real Estate Market of University of Warmia and Mazury in Olsztyn, Poland
- Department of Geodesy of University of Warmia and Mazury in Olsztyn, Poland
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Scientific journal BALTIC SURVEYING is indexed in databases Agris, CAB Abstracts, EBSCO Applied Science & Technology Source Ultimate, EBSCO Discovery Service, Complementary Index and Primo Central (ExLibris).

Information about the journal is placed on the website: www.balticsurveying.eu

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CONTENT

DOI: 10.22616/j.balticsurveying.2021.15.001

EVALUATION OF RECREATIONAL TERRITORIES A CASE STUDY OF BIRŽAI TOWN OF THE REPUBLIC OF LITHUANIA

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Abstract
The need for recreational territories in urban areas has recently become increasingly relevant. In order to create and develop an effective urban green space system, it is necessary to study its main structural components. The aim of the research is to perform the analysis and evaluation of recreational territories of Biržai town. During the research, the territory of Biržai town, green spaces were analyzed, the main cadastral data of recreational territories as real estate objects were determined: areas, land use purposes, land use types, special land use conditions and easements. The influence of cadastral indicators in adapting objects to recreation and tourism has been determined. Possibilities of recreational activities in Biržai town were evaluated. Following the SWOT, a generalized analysis of the situation was provided. The performed research revealed that the town of Biržai is dominated by built-up and water-occupied territories. The areas of the territories intended for recreation do not correspond to the areas provided for in the Master plan of Biržai town. The green space system is uneven, the recreational territories do not ensure a full life for the townspeople. The town lacks green spaces adapted to various activities, and the integration of water bodies into the urban living environment is moderate. It is proposed to activate communities in the development of living environment in Biržai.
Key words: recreation territories, green spaces, protected territories, Biržai town.

Introduction

In order to achieve sustainable urban development, sufficient attention must be paid to the proper planning of the urban recreational system, public spaces as well as green areas. The current general and detailed planning does not solve the problems that arise.

Extensive scientific literature (Aronson et al., 2017; Dagytė-Mituzienė, 2015; Deveikienė, 2016; Katkevičius et al., 2012; Jakovlevas-Mateckis, 2008; Juškaitė, Gurskienė, 2015; Katkevičius et al., 2012; Lai et. al., 2019; Landry, 2005; Prapiestienė, 2003; Russo, Cirella, 2018; Stauskis ir Skripkiūnas, 2015; Veitch et al., 2020; Wen et al., 2020 and other) emphasizes the importance of green spaces for the preservation of the natural environment, biodiversity in urban areas and most importantly – people. Cities play important roles in the conservation of global biodiversity, particularly through the planning and management of urban green spaces (Aronson et al., 2017). According to K. Jakovlevas-Mateckis (2008), green spaces with buildings form the structure of urban space, which is the open green space of the town (recreational zones, squares, parks). In order to create good conditions for the population to work, study and relax, an urban green space system is being built in the cities and towns, in particular by using existing natural resources. Optimal area ratios must be maintained, such as covered and green areas for the rest and health of the population. As Wen et al. (2020), urban planners should choose effective planning tools based on a good understanding of the local context and appropriate target groups.

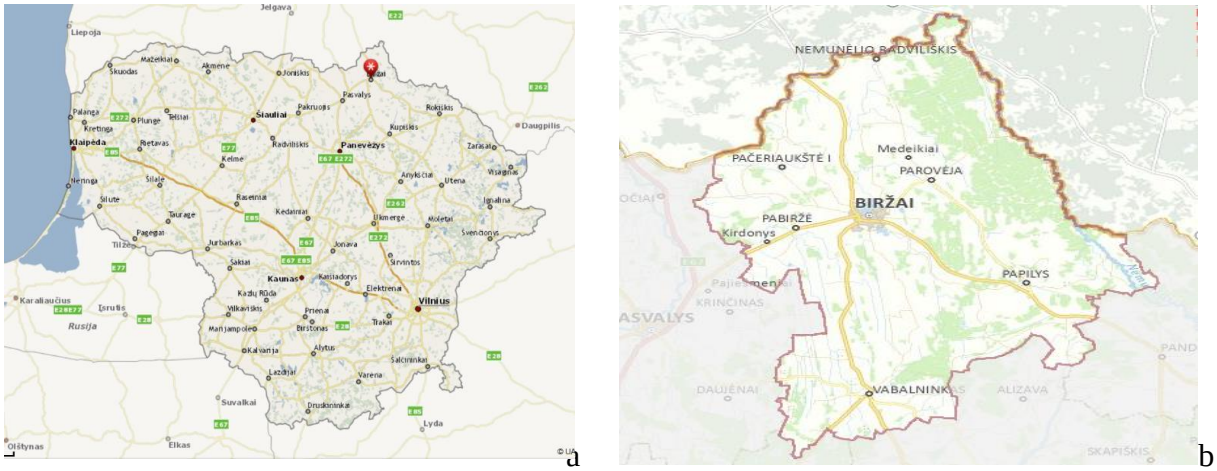
In addition, according to Ch. Landry (2005), in the development of cities and towns, the historical heritage of the past must be taken into account in order to ensure that the needs of the inhabitants of the city or town are not "drained and exhausted.". According to R. Prapiestienė (2003), in order to achieve good results in the field of urban afforestation, it is necessary for all responsible institutions to be united, purposeful, and planned. No less important is the involvement of local communities (Juškaitė, Gurskienė, 2015), especially when considering planning documents.

In order to create and develop an effective urban green space system, it is necessary to study its main structural components: the natural and anthropogenic environment. In order to achieve sustainable urban regeneration, it is worth paying due attention to identifying the recreational potential of the town, finding opportunities to develop the recreation system, ensuring its smooth functioning both in the internal structure of the town and in the regional context.

The object of this study was the town of Biržai in northern Lithuania. According to G. Gaudiešiūtė (2009), today the town of Biržai loses clear structural boundaries, it is not clear where the old town and where its boundary is. Biržai town center is gradually losing its historical originality and integrity.

The aim of the study was to determine the distribution of recreational territories and heritage objects in Biržai town and suburbs, to analyze the separate green spaces of Biržai town, to evaluate the quantitative and qualitative characteristics of recreation and recreation territories and their significance for both locals and incoming tourists. Similar problems are relevant in other urban areas as well.
The aim of this research is to perform the analysis and evaluation of recreational territories of Biržai town.

Methodology of research and materials
The object of the research is the recreational territories of Biržai town.
Biržai is a town in northern Lithuania, Aukštaitija, Panevėžys county, 66 km north of Panevėžys, located 201 km north of Vilnius and 90 km south of Riga, near the Latvian border (Fig. 1).



a b

Fig. 1. Geographical position of the town in relation to the country (a) and in relation to the district (b) (compiled according to www.geoportal.lt)

The town of Biržai selected for the analysis has great potential for the development of tourism and recreation. Attractive recreational territories that meet the needs and significant natural and cultural heritage objects should be considered as the most important factors in the development of these activities.
The analysis of scientific and legal literature, statistical data, spatial planning documents and other sources was performed during the research. Statistical data provided by the National Land Service under the Ministry of Agriculture, the Department of Statistics of Lithuania, the State Enterprise the Center of Registers and other institutions, information of the Geographic Information System (GIS), which is provided on the website www.geoportal.lt, was collected and analyzed. Information was collected from the following spatial datasets: Georeferenced Base Cadastre (GRPK), Abandoned Lands (AŽ_DRLT), Protected Territories, etc.
Two questionnaires were conducted. The questionnaires were posted on the portal www.apklausa.lt and filled in in March-April 2020. According to the first questionnaire (it consisted of 25 questions), the aim was to find out the opinion of the residents of Biržai about the adaptation of recreational territories of Biržai for recreation, their attendance and satisfaction of the needs of the residents. The questionnaire was read by 292 citizens and only 55 respondents took part in the survey. The reliability of this sample is 86%. The second questionnaire (consisting of 18 questions) was addressed to professionals in the field, i. experts to clarify their position. Links to this survey were sent by e-mail to the municipal administration, Biržai Regional Park Directorate, Environmental Protection Agency, Biržai Territorial Division of the National Land Service under the Ministry of Agriculture. It was attended by 10 experts. A SWOT analysis was performed to summarize the situation.
The results of the study are presented using descriptive and graphical representation methods.

Discussions and results
The following analyzes were performed for the evaluation of the town's recreational territories: Biržai town recreational territories, land fund distribution and natural framework, urban, protected territories

and public spaces, green spaces system and the level of satisfaction of their recreational needs in the town.

In order to perform the analysis of recreational territories of Biržai town, it was first determined how the land use in this town was distributed (Table 1).

Table 1

Distribution types of land use in the territory of Biržai town (compiled according to Lietuvos Respublikos žemės..., 2016, 2019)

Type of land use	Area ha		Area change 2016-2019, ha	Area of total town area %	
	2016	2019		2016	2019
Agricultural land	294.51	256.82	-37.69	16.5	16.5
Forests	117.22	64.88	-52.34	6.6	4.2
Roads	90.67	82.11	-8.56	5.1	5.2
Built-up area	670.62	573.53	-97.09	37.6	36.9
Water bodies	459.89	453.15	-6.74	25.8	29.2
Other land	149.56	124.64	-24.92	8.4	8.0
Total in Biržai town	1782.41	1555.13	-227.28	100	100

During this period, not only the land use structure changed, but also the area of the town territory as well, as the boundary of the Biržai town territory was adjusted. It can be seen that built-up and water-filled areas predominate, which in 2019 occupied 66 percent of the town area.

The town is not characterized by the abundance of green spaces and their quality. An important compositional axis of Biržai town – two rivers, Širvėna and Kilučiai lakes, the main green areas of the town are located around them and a natural framework is formed. These important natural elements complement the urban structure of Biržai.

The distribution of recreational territories and cultural heritage objects in the town and suburban cadastral units as well as in separate protected territories was analyzed (Table 2).

Table 2

Distribution of recreational territories and objects in the territory of Biržai district (compiled according to ŽIS paslaugos, 2020)

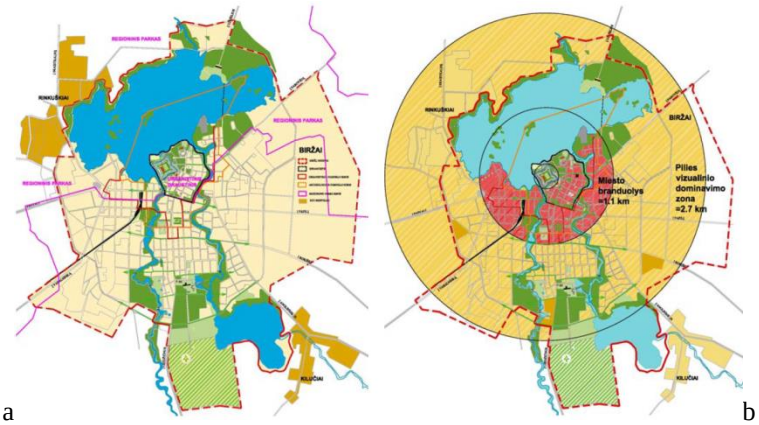
Localities	Total area, ha	Recreational territories				Area of cultural heritage objects				Number of point cultural heritage objects
		number	area, ha	%	average area, ha	number	area, ha	%	average area, ha	
Total in 8 cadastral units	33437.11	24	63.16	1.30	14.69	71	709.19	2.12	23.37	26
Average in 1 cadastral unit	4179.64	3	7.90	0.16	1.84	8.88	88.65	2.12	2.92	3.25
In Biržai regional park	14405.76	17	52.27	0.36	3.07	42	662.09	4.60	15.76	25
Total in 8 reserves	4106.42	5	16.74	3.70	7.15	25	452.72	11.02	47.80	16
Average in 1 reserve	821.28	1	3.35	0.74	1.43	5	90.54	11.02	9.56	3.20

Explanation: * - from the total area of the cadastral unit or protected territory

It has been established that the objects intended for recreation are both in the town and in the suburban cadastral units. Therefore, these territories are included in the area of direct influence of the town of Biržai and are analysed with the town. On average, there are about 9 cultural heritage objects in one cadastral unit, which cover an area of almost 90 ha. As many as 42 cultural heritage objects belong to one cadastral unit of Biržai town, which makes up 42.43% of the total area of the cadastral unit. All these objects also fall within the boundaries of Biržai Regional Park. 25 cultural heritage sites have been identified in the reserves, which should be preserved as well.

Therefore, in order to adapt the cultural heritage to cognitive tourism, it is necessary to prepare special plans for the territories of protected objects, specifying their boundaries and valuable features, providing for protection measures and their implementation. The historical places, mound, manors and other objects of Biržai Old Town should be better adapted to cultural-cognitive tourism and events.

Urban analysis. The most significant accent of Biržai town is considered to be the castle site with Radvilų Castle. This object requires a visual dominance zone of about 2.7 km. Biržai is a small town. Almost the entire territory of Biržai town falls into the zone of visual dominance of the castle. This means that no high-rise construction can be carried out in this area that could negatively affect the visual perception of the town. In addition, a radius of 1.1 km provides the most protected territory in the core of the town. It includes the old town, urban and archeological monuments, the territory of the regional park with the boundaries of the urban reserve. This is the most sensitive area of the town, where the height is limited (predominantly 3-4 floors, in case of visual shadows – possible height up to 5-6 floors) (Fig. 2).



a b

Fig. 2. Administrative formations of the town and accesses (a), Visual dominance zones of the castle in the town (b) (compiled according to Gaudiešiūtė ..., 2009)

It should be mentioned that the town of Biržai is rich in deformations of the urban structure. According to G. Gaudiešiūtė (2009), usurpation of the most attractive places for buildings in the historical core of the town causes deformations in the functional sector, creating visual pollution. The compositional as well as urban and landscape principles of the architectural structure are ignored.

Protected territories. The system of protected territories is important in adapting territories to recreation. The examined Biržai town and suburban territories include the following protected territories: natural framework territories, complex protected territory – *Biržai Regional Park, as well as nature reserves, cultural heritage values and other territories.*

In the solutions of the Master Plan (2014) of Biržai, when forming a high-quality urban structure and architectural solutions, it is planned to preserve the elements of the natural framework. It is emphasized that it is necessary to identify all applicable strategic development methods for the urbanized areas of Biržai.

One of the most significant natural-cognitive aspects is Biržai Regional Park. This park has a relatively high concentration of natural objects to visit. Biržai Regional Park was established in order to preserve the landscape of the Lithuanian karst region, its natural ecosystem and cultural heritage values, to manage and use them rationally. This park includes Biržai and Pasvalys districts, its management is located in Biržai. The total area of this park is 14,406 ha. In the town of Biržai it occupies 830.27 ha, i.e. 40.3% of the area of this town. The activities carried out by the Park Directorate and other environmental institutions significantly contribute to the preservation of the most valuable places and objects, their adaptation to public needs, their research, advertising, and cognitive activities.

Another unique phenomenon of the Biržai landscape is karst sinkholes. It is the dissolution of dolomite and gypsum deposits in the depths of the earth when they are washed by surface, ground and groundwater and when a layer of rocks (ground) covering it falls into the underground cavity. This is how gypsum karsts are formed in Northern Lithuania: underground lakes, pits, sinkholes, of which there are more than 9 thousand.

Biržai district is the most affected of karst phenomena in all districts of the country. The formed formations are used as unique tourist attractions. There are 75 sinkholes of various ages, sizes and depths

in the territory of Biržai town. They are unevenly distributed in the territory (Biržų miesto..., 2014). Sinkholes open in the most unexpected places. Houses, roads, trees collapse. Investigations are being carried out to evacuate people and protect property in the area in the event of a threat. The uncovering of underground layers in non-hazardous areas could lead to the establishment of natural museums. People are interested, but often know quite little about such phenomena. There are no more such places in Lithuania, therefore exceptional objects could be presented more actively and ingeniously.

Prior to the construction in Biržai, it is mandatory to carry out geological surveys, confirming that no gypsum layers have formed at the construction site.

Therefore, due to unique natural phenomena and picturesque natural environment, recreational and cognitive tourism could be one of the priority areas in the district and in the town of Biržai. Particular attention should be paid to improving the quality of the natural environment and adapting areas to tourism and recreation.

Green spaces system. A sustainable recreational environment based on green urban spaces is important for the needs of both town guests and especially locals. According to the Master plan of the town territory (Biržų miesto..., 2014a), it is envisaged that the territories of individual green areas are assigned to the land redeemed by the state. In order to form the image of an attractive town and to form a full-fledged system of green areas, it is necessary to:

• preserve a unique natural and cultural environment;
• preserve all existing green spaces in the urbanized part of the town;
• not to carry out construction in the most valuable areas of the town from the point of view of environmental protection and aesthetics;
• form separate green areas in newly acquired urban areas;
• form protective green spaces in the territories of utilities and infrastructure;
• promote the formation of green connections and protective green spaces and the management of existing ones;
• strive for high quality of the elements of the green space system category.

Evaluating all the mentioned arguments, the principal framework of the green space system, which is represented by the functional priority zones of green areas and recreational territories, is determined (Biržų..., 2014b).

It has been established that most of the areas required for recreation cannot be transferred to private ownership. By the decision of Biržai District Council of April 20, 1998, a list of non-privatizable beaches, parks and squares was approved in Biržai, in which the main public spaces of the town are classified as non-privatizable.

In the management of state property, the interests of the society are protected, and opportunities to visit significant objects are ensured. The non-privatizable areas in Biržai town are a potential territorial reserve, forming the system of green spaces in Biržai.

According to the data of the State Enterprise Center of Registers, land plots were formed in 2011-2017 for the individual green areas of Biržai town, which represent Biržai town and are most visited, and they are registered in the Real Estate Register. The purposes, uses, special land use conditions and easements have been established for these territories (Table 3).

The total area of parks, squares registered in the Real Estate Register in Biržai is 90.81 ha and makes up 5.8% of the total area of the cadastral unit of Biržai town. We see that all the main parks of Biržai and other green spaces are registered. 92% of the public space area has been allocated for *Other* land use purposes. According to the type of land use, 54% of the examined objects are classified as separate green spaces. These are plots of land that can be used for separate recreational, scientific, cultural and memorial, as well as protective and ecological green areas.

The type of common use is granted to land plots intended for public use, i.e. the establishment of botanical and zoological gardens, cemetery areas or corpse storage structures as well as public spaces in urban areas. This type of land use is granted to 31% of the analyzed objects and covers an area of 20.24 ha, which covers 22% of the total area of the analyzed objects. This area also includes the projected park with an estimated area of 14.25 ha.

Two types of land use have been identified for the Youth park, the potential of which has not been fully exploited: Recreational territories and Public areas are land plots intended for short-term or long-term (stationary) recreation with recreational buildings.

Table 3

Data on state land plots for recreation registered in the Real Estate Register in Biržai town (compiled according to the data of the State Enterprise Center of Registers, 2020)

Name of the object	Area ha				Purpose	Type of green spaces
	total	average for 1 object	min	max		
Square near Birutė Monument, J.Janonis Square, Park near the Reformed Church and Projected park	20.24	5.06	0.88	14.25	Other	Territories of common use
A.Dauguvietis, Agaras street, Žvejų street parks, other 4 land plots	45.84	6.55	0.43	12.24	Other	Territories of separate green spaces
Youth park	7.71	7.71	-	-	Other	Recreational territories. Territories of public purpose
Astravas Manor Park	18.09	18.09	-	-	Conser-vation	Land plots of cultural heritage objects

Explanation: * - territories of common use of cities, towns and villages or municipalities

According to the solutions of the master plan, the system of green spaces in Biržai town should occupy an area of 314.88 ha, which would make up 15.3% of the area of the town. Including *separate recreational green spaces* (parks, town gardens, green connections and other recreational green areas) would cover 195.35 ha (9.5% of the urban area). The remaining part should go to *ecological green spaces* – 38.84 ha (i.e. 1.9% of the urban area). These data do not correspond to the real situation. The existing green area should more than double.

The special conditions of land and forest use established for land plots do not have a negative impact on the economic activity of the analyzed objects (implementation of reconstruction technical projects, improvement of infrastructure, operation) and newly created objects intended for rest and recreation. Persons who manage the objects entering the protected territories are provided with conditions to expand recreational activities, to reveal the beauty and uniqueness of the karst region. In nature reserves and other protected territories, restrictions related to the performance of economic activities on agricultural land plots (use of pesticides, herbicides, fertilization of fields) have the greatest impact.

Easements were established in 62% of the examined land plots. In the parks of A.Dauguvietis and Astravas manor, easements of buildings have been established, which give the right to use the building in the park to natural persons. All other established easements grant the right to construct, service, use underground and terrestrial communications. After analyzing the easements established for the objects, it can be stated that they do not cause problems for the use of land plots. The easements provided to the objects in question provide an opportunity to improve the infrastructure of green spaces by building networks. There is an opportunity to install lighting, public toilets and other elements needed to improve the infrastructure.

All analyzed objects are owned by the Republic of Lithuania, according to the loan agreement they are used by Biržai district municipality.

In addition to individual green areas that are on other land, urban green spaces also include forests that are on forestry land. These areas are as independent elements of the town structure. Forests perform recreational, environmental and aesthetic functions. In Biržai, forests cover a relatively small area – 32 ha (1.8% of the town area).

All the main public areas of the town are formed by plots of land and are subject to land use restrictions and easements, which will only facilitate the installation and management of the necessary infrastructure in the areas.

Evaluation of recreational territories. The main recreational resources in Biržai district and the territory of the town are the natural environment (picturesque landscape, water bodies), territories of cultural heritage objects and other objects adapted for recreation (recreation and entertainment infrastructure). An assessment of the possibilities of recreational activities that are currently being carried out or may be carried out in the near future in a five-point system was performed (Table 4).

Table 4

Types of recreational activities planned in Biržai district (compiled according to Biržų miesto..., 2014)

Recreational activities	Activity description \ Veiklos apibūdinimas	Scoring opportunities *
Common	Common, rejuvenating (healing), promoting human recreation in nature, without setting additional special goals	4
Cognitive	Travel and recreation in natural or cultural environments. Cognition of the environment, acquaintance with its history, properties	4
Sports	Active activities and recreation in the natural or artificial environment for the purposes of physical education	2
Entertainment	Relax in nature or in an artificial environment adapted for that purpose, participating in various types of entertainment	2
Business	Relax in nature, collecting forest products, hunting, fishing	4
Therapeutic	Relax in a SPA setting to restore or improve health	3
Average		**3**

Explanation: * - maximum scoring 5 points

Possible recreational activities in Biržai are evaluated as *average* (3 points out of 5). The total recreational potential is formed from recreational resources throughout the district municipality. In picturesque areas near water bodies (rivers, lakes), recreational activities are rated well (4 points out of 5).

In order to expand common and recreational forms of recreation, it is necessary to increase the tourist attractiveness of the green spaces of Biržai, especially forests. This requires the expansion of resort infrastructure by installing shelters and fireplaces for several groups of visitors as well as expanding additional entertainment and sport infrastructure (by installing volleyball, children's playgrounds, etc.). Particular attention should be paid to recreational areas near water bodies suitable for swimming, boating and fishing. In such resorts it is necessary to install appropriate beach infrastructure, footbridges.

The perspective of therapeutic recreation in Biržai district is related to Likėnai sanatorium, located near Biržai town. Biržai district should purposefully create the necessary special medical recreation and recreation infrastructure. Therefore, more attention should be paid to the management of the recreational environment of the sanatorium.

In summary, it can be stated that the highest-ranking recreational territories in Biržai district municipality, primarily covering the town of Biržai and the Regional park, create opportunities for the development of recreational territorial systems and complexes of national importance. The planned types of recreational activities in Biržai are cognitive, therapeutic, recreational, entertainment and sports activities. However, at present, the opportunities for the development of recreation are assessed by the authors of this work as moderate.

The recreational spaces of the town were appreciated by the residents and land management as well as environmental specialists – experts. Experts who took part in the questionnaire survey asked “Is the creation of a unified, functional system of green spaces an important step towards sustainable urban development?” 100% of the experts noted that it is important. When asked whether green spaces and green plantations are evenly distributed in Biržai, 70% of experts answered that it was uneven.

To the question "What should be done to improve the system of green spaces in Biržai town?", 66.7% of experts answered that it is necessary to distribute and manage the town's green spaces more rationally. Opinions of the residents differed, but the largest part, i.e. 26% of the respondents believe that more attention should be paid to the management of natural water bodies and their integration into the town's infrastructure. The opinion of experts and residents coincided when they were asked, “Is there enough money allocated for the maintenance of green spaces in Biržai?”, 70% of experts and 49.1% of the residents think that the funds are insufficient. It can be said that residents have little interest or are not sufficiently informed about the allocation of funds for the maintenance of green spaces. According to experts and residents, a large part of the funds can be attracted from the EU structural funds. When asked “Who should take care of the maintenance of green spaces?”, 41.9% of the respondents believe that the municipality, but 23.9% of the residents themselves would agree to contribute to the maintenance and management of green spaces.

To the question "What is missing?", both residents and experts answered that there is a lack of quality planning and equipment, the existing parks and squares were once planted with trees, but the necessary infrastructure was not installed. In some town elderships, there are no green spaces at all for rest and recreation, and the planned spaces are not sufficiently integrated into the residential area. In the central part of the town, green spaces are awkwardly arranged, lacking the integrity and accessibility.

Summarizing the results of the survey, it can be stated that in the town of Biržai there is a lack of local green spaces specially adapted to separate residential quarters (territories of elderships). The condition of the current green spaces is *average*, there are noticeable unevenness of their distribution. The lack of local green spaces in the blocks of multi-apartment houses in J.Basanavičius and Gimnazija elderships is especially pronounced. In Jovaras and Kęstutis elderships, local green spaces are marked only in those parts of the town which are planned in detail as well as in the newly formed, green connections.

Perspectives of development of recreational territories of Biržai town. In order to identify and distinguish the main problems related to the creation, management, development and similar issues of Biržai town recreational territories and to predict development perspectives, the SWOT evaluation of Biržai town recreational territories development was performed (Table 5).

In recent years, in Biržai, more attention and investments have been paid to a representative group of central town green areas, and plots of land are planned for new local green areas (parks and squares) in residential ones, but no afforestation projects have yet been prepared for active and passive recreation zones. When developing the green space system of Biržai town, more attention should be paid to the development of regional and especially local green areas. Local green areas should be included in the general plan as integral elements of the green space system.

Part of the solutions of the Master plan of Biržai town territory is intended for the development of individual green areas, town forests and green areas of other recreational territories. The planning of the green space system is carried out by ensuring territorial integrity and functional continuity, and is aimed at improving the condition of the natural environment and strengthening the ecological balance.

It is in this way that the solutions of the general plan will have an impact on the total energy consumption, reduction of air, soil and water pollution, sustainable development of recreational resources, and all this will have a positive impact on the health of the population. The planned solutions of the general plan will have a direct impact on the preservation of natural areas, their adaptation to the needs of society and the landscape. The next important steps are the implementation of these provisions.

Table 5

Evaluation of Biržai town recreational territories development

STRENGTHS	WEAKNESSES
The district municipality borders the Republic of Latvia. As a result, a lot of tourists not only from Lithuania, but also from Latvia visit Biržai.	The district is located quite far from the largest cities of the country, so its geographical location is not very favourable for tourism development.
Biržai Regional park occupies most of the town area. An important task of this park management is to create favourable conditions for recreation.	Recreational activities and cognitive tourism are underdeveloped in the Regional park.
The landscape structure of Biržai district contains enough unique natural and anthropogenic components that promote the development of tourism.	Not all cognitive objects are properly arranged, there is a problem of their accessibility, there is a lack of parking lots near the objects.
The district is distinguished by unique karst phenomena.	In the territory of Biržai town, some interesting, exclusive sinkholes are not suitable for cognitive visits.
	The earth collapses in unexpected places. The current situation is insufficiently researched and monitored.
There are many exceptional cultural heritage sites both in the town and in the whole district.	The objects are not fully adapted for recreation. Many of them lack well-equipped paths, benches, lighting, rubbish bins, attractive green spaces, and the environment is not adapted to the needs of the disabled.
There are enough public spaces in Biržai for active recreation and leisure.	There are no conditions for sports in parks and squares. The lack of sports infrastructure reflects the small number of sporting events.
	There is a lack of attractive tidy spaces suitable for passive recreation.
In the central part of Biržai, there are many interesting and significant sights representing Biržai.	The center is fragmented (dispersive), - the functional and cultural centers of the town do not coincide.
	Insufficiently arranged town central representative spaces.
The pedestrian bridge connecting the Astravas manor and the town of Biržai attracts visitors. There is a hiking and cycling path in the entrances.	There is a problem with the accessibility of the objects, the access street is narrower than the pedestrian and bicycle path, there are no parking lots, rubbish bins, there are no public toilets.
	There is no infrastructure in the Youth park, where tourists and town residents can relax, have a picnic and take a walk.
Biržai is a town with several water bodies - parts of the Apaščia and Agluona rivers, Širvėna and Kilučiai lakes.	Unattractive beaches, little use of lake opportunities.
	Most of the shores of water bodies are undeveloped, with poor access to them. These reservoirs are not sufficiently integrated into the urban environment.
POSSIBILITIES	**THREATS**
Biržai District Municipal Council in 2014 approved a special plan for the development and management of the green space system of Biržai town, creating opportunities for the development of the green space system.	Rapid population decline in the district and surrounding regions.
Wider use of EU structural funds for green space management and development.	Legislation, partially restricting opportunities.
Reconstruction projects of the central part of Biržai and other objects intended for recreation and recreation have been prepared.	Due to limited budget funds, the municipal administration is not able to improve the quality of the objects to be visited.
It is planned to apply the objects of attractions to tourism and related activities.	Insufficient attractiveness of the objects, which determines the choice of tourists to come to this area.
	The seasonality of tourism is especially felt.
More active involvement of local communities, companies and individuals in the management of territories.	The public is indifferent to involvement in site management. According to a large part of the local population, the management of the territories must be taken care of by the municipal administration.

Conclusions and proposals

1. It was established that the town of Biržai is dominated by built-up areas and water bodies (in 2019, they occupied 66.1% of the town area). In the cadastral unit of Biržai town, the area of 662.09 ha (42.4%) is occupied by the territories of 42 cultural heritage objects, most of which can be adapted for recreation. The natural framework, which complements the urban structure of Biržai, is underused.
2. It has been established that the analysed objects intended for recreation fall within the boundaries of protected territories. Therefore, the conditions for their owners to expand recreational activities, opportunities to reveal the beauty and uniqueness of the karst region have improved. The easements provided to the objects in question provide an opportunity to improve the infrastructure of green spaces by building networks. There is an opportunity to install lighting, public toilets and other elements needed to improve the infrastructure.
3. Untapped potential of the natural framework for recreation: movement around the lake and along the rivers is not consistently ensured, there is a lack of picturesque lighting, opportunities to stop at intermediate stops when traveling. The potential of historical values is only partially exploited. The center is fragmented (dispersive), the functional and cultural centers of the town do not coincide. After analysing the results of the survey of experts and residents, 72.7% and 40%, respectively, believe that the town of Biržai has enough green spaces, but there is a lack of greenery. According to the respondents, in order to improve the system of green spaces, it is necessary to manage the existing green areas more rationally, using the EU structural funds, involving the public in their management.
4. Using the experience of foreign towns, it is proposed to activate the communities in Biržai in creating a living environment. After arranging the central part of Biržai town, A.Dauguvietis park with accesses, Youth park and Astravas manor homestead park, it is proposed to expand their recreational and cultural functions and adapt them for visiting and getting to know, to give the territories a suitable role in the life of the town community.

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DOI: 10.22616/j.balticsurveying.2021.15.002

ANALYSIS AND POSSIBILITIES OF APPLICATION OF THE AMERICAN EXPERIENCE OF AGRICULTURAL LAND USE ORGANIZATION

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Abstract
Having analyzed research results, it is ensured that sustainable land use of US agricultural lands for the support to farmers to improve the efficiency of their major activities and adherence to the principles of soil protection and rational land use in farms. An analysis of the American experience allows us to make conclusions that the success of the process of improving land relations depends on the level of their scientific validity, the degree of balance of government regulation and the degree of coordination of participants' interests in transformations and land market transactions. Land lease in the United States of America as one of the economic methods of land use regulation has been analyzed in the article. It has been established that long-term lease relations are beneficial for both parties concerning soil improvement and pollution control in case of clear legislation. Having analyzed foreign experience, the main measures of land use rationalization in the USA, which people can use in Ukraine, have been proposed. It is also possible to implement the US experience in actively controlling the ecological condition, intended use and other quality characteristics of agricultural land to improve regulation of land use in Ukraine. After analyzing the measures for land protection in the United States, taking into account the considered and researched American experience of agricultural land use, ways to improve the existing system of use and protection of agricultural land in Ukraine are proposed.
Key words: foreign experience, agricultural lands, rational use, lease.

Introduction

It is important to study the tendencies of world experience and the requirements of modern production to introduce an effective system of organization of rational use of agricultural land. The US land protection and erosion protection system in the United States is well developed and has a lot of participants. Private farmers are the main subjects of protection, as they make decisions on land preservation, mostly independently take measures for their practical implementation. The efficient system of rational use of agricultural lands is mostly voluntary. There are not only many land protection and rationalization programs in the United States, but also several services for the control, protection, and improvement of agricultural land use. In total, there are more than 20 federal environmental programs regulated by the Department of Agriculture. Involuntary and regulatory programs have a small share of US environmental policy and focus more on pollution control and chemical use. The experience of this country is fascinating for Ukraine because in addition to the similarity of natural conditions, the presence of erosion and degradation processes and similar legislation, the US experience is positive and tested in terms of implementing an economic mechanism for land use in Ukraine.

Methodology of research and materials

The aim of the work is an attempt to analyze land protection measures in the United States, considering the reviewed and researched American experience in agricultural land use, to suggest ways to improve the existing system of use and protection of agricultural land in Ukraine, to highlight tendencies in land protection and their introduction in Ukraine.

The following tasks have been accomplished in order to achieve the aim:

1. to consider key directions of implementation of the process of improving land relations in the United States;
2. to analyze the evolution of land relations in the United States and identify major characteristics of agricultural land use organization;
3. to express the effectiveness of the program of soil protection measures "The Conservation Reserve Program" in the United States;
4. to reveal the measures in the USA which can be implemented in Ukraine based on the considered and researched American experience of agricultural land use organization.

The dialectical method of scientific cognition, which allows studying social and economic phenomena in interrelation and dialectical mutual development on the basis of methods applied, has been objectively substantiated in this article. It is used the method of similarity, which is based on the conclusions about the similarity of causes or consequences in scientific research when it is necessary to determine the cause of any phenomenon that occurs due to different conditions. Considering the presence of circumstances common to all phenomena, it is applied, as a rule, in the study of economic phenomena that can be observed in specific conditions, and does not require artificial intervention in the process of the studied phenomena. The monographic research method allowed studying the experience of land relation improvement in foreign countries thoroughly and

identifying opportunities for its application in Ukraine. The results of the conducted research using a graphical method in the form of graphs and charts have been illustrated and demonstrated.
Similarly, the use of the following methods: synthesis methods, analysis, induction, and deduction are combined in the article. Firstly, synthesis methods (*Greek* synthesis – combination, connection) allow researching the phenomenon in its integrity, unity and relationship of its components. Secondly, analysis – division of the subject into constituent elements. Thirdly, induction (*Latin* induction – guidance, motivation) is a method of forming a logical conclusion from the individual to the general. Fourthly, deduction (*Latin* deduction – derivation) is a method of forming a logical conclusion from the general to the individual and analogy, due to which people can achieve knowledge of some objects and phenomena based on their similarity with others. It allowed a comprehensive investigation of the main factors influencing the level of perfection and efficiency of land relations in the United States and concerning this analysis, the main ways to improve land relations in Ukraine can be determined.
The materials used in the work are the works of scientists (articles in periodicals, monographs) relating to the American experience of rational land use and data from US government websites on land conservation and protection programs.

Discussions and results
The aim of ensuring sustainable land use of US agricultural lands is to support agricultural producers (farmers) for efficiency increase of their main business, and compliance with the principles of soil protection, rational land use in farms. The policy of development and support of agriculture in the USA is based on the principles of continuous and effective accounting of agricultural lands.
An analysis of foreign experience allows us to make conclusions that the success of the process of improving land relations depends on the level of their scientific substantiation, the degree of balance of state regulation as well as the coordination of participants' interests in transformations of land and market transactions (Fig. 1).

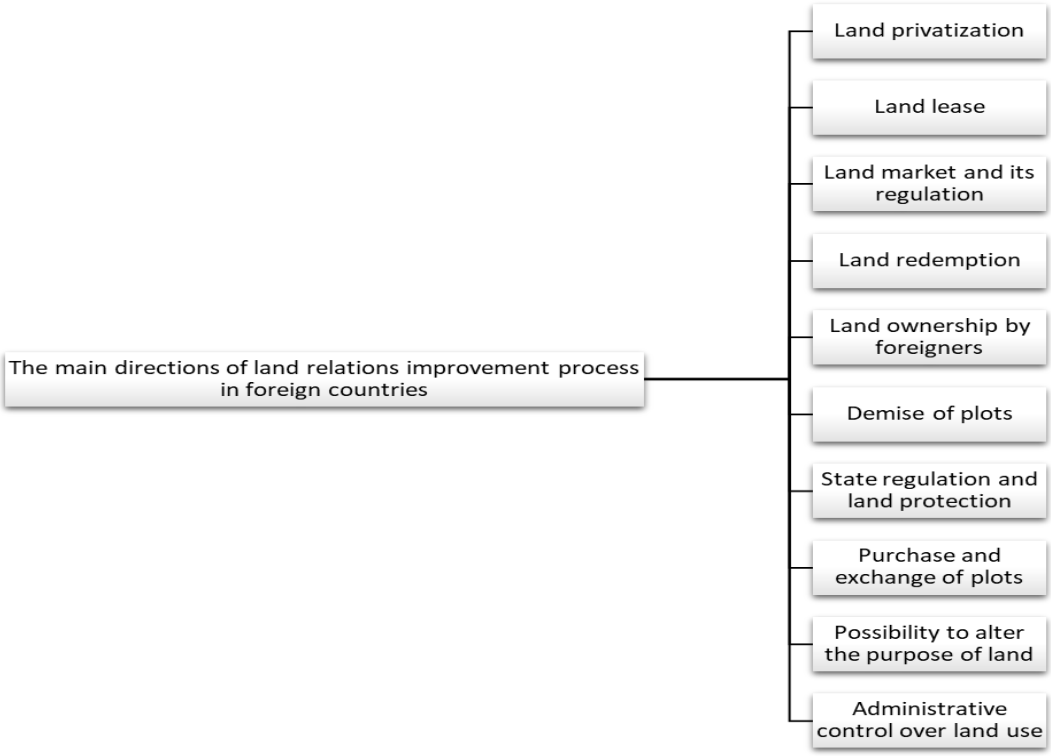

Fig. 1. The results of generalization of the US experience in the implementation of the main directions of the process of land relation improvement in agriculture. (Sources: Балюк, Гапєєв, 2016; Ботезат, 2016; Височанська, 2015; Грещук, 2017; Коритник, Шпичак, 2009)

Land relations and directions of their regulation in the USA are peculiar to some extent. The history of land relations in this country can be divided into two stages. In the first century of the country's existence the main direction of state regulation of these relations by expanding private land ownership was provided. The next stage of the formation of land relations is characterized by the restriction of land areas in private ownership, their repurchase by the state and the strengthening of control over its condition and use in private ownership. Today, the federal government owns 40% of US land fund but none of the arable lands. Most of the lands of the largest state in the United States Alaska as well as Nevada, Utah, New Mexico, Wyoming and Dakota are of federal property (Черевко, Дудич, 2013). The state repurchases land from farmers to transfer it to state or local ownership

and then leases it to large producers. A lot of farmers in the United States manage leased land (29% lease some of the land they manage, 11% manage on the leased land), paying the landowner mostly a fixed portion of the crop or a fixed fee. The latter version is quite common, but it is characterized by a relatively higher risk for the farmer than for the landowner. Although due to the large amplitude of fluctuations in yield levels, the first version is even riskier for the farmer. Sixty percent of farmers in the United States own their lands.

In the United States, the basis for the preservation and restoration of land resources, improving the environment, people's living conditions is the rational organization of agricultural landscapes. In this context, special laws and enshrined economic mechanisms for the ecologization of land relations in law have been adopted. It obliges all land users to comply with these requirements, regardless of land size. In addition to counter-agreements between farmers and the state as well as economic incentives for land users, these mechanisms include emerging ones in Ukraine. They are the following ones: land-use planning with the allocation of environmentally sensitive areas; development and implementation of comprehensive programs that take into account agricultural and environmental aspects of land use; restrictions on the timing of agricultural work, the use of certain agricultural machinery, which are discussed with the landowner before she or he acquires ownership. The main goal of conserving and restoring natural resources in the United States for all participants in this process is to ensure much better use of soil, water, air and biodiversity. Two major approaches in the implementation of this task are used: market one and partnership. The market approach is to implement market principles and mechanisms for protection, which provides a clear system of property rights and the use of market-oriented instruments, including government compensation, benefits, payments and loans to landowners to minimize negative externalities in the environment. The principle of partnership determines the broad involvement of the main participants in this process in land protection, namely: farmers, landowners and land users; government agencies in the field of environmental protection; special local entities, as well as colleges, universities, public organizations, land trusts, and others. (Черевко, Дудич, 2013). In our opinion, this principle should be applied in Ukraine, involving all possible institutions and sources of funding for land protection.

It is necessary to create a special technically competent service responsible for soil monitoring all over the country to solve the problem of information support. Ukraine has a unique experience in organizing large-scale monitoring of soil conditions on agricultural lands due to agrochemical certification, which have been conducted since 1964 by the State Institution "Institute of Soil Protection of Ukraine" (State Institution "State Soil Protection"). Concerning setting up the land market, it is advisable to create such an institution to monitor soil quality, which testifies the successful experience of the United States, where T. Roosevelt established the Soil Protection Service in 1935. Now it operates as part of the Natural Resources Conservation Service USDA (Балюк, Мірошниченко, 2021).

In general, land relations of economically developed countries are carried out today in a developed land market, which is a real form of expression of these relations. It includes virtually all land transactions or, at least, both land leases and land plot exchanges, especially the purchase and sale of land. In this case, the implementation of market transactions with land concerning the purchase and sale of land plots means the purchase and sale of property rights to these plots, rights to use them or property rights and use at the same time.

A positive characteristic of the legislation governing land market relations in the United States is that it allows for the compulsory withdrawal of lands and the transfer of them, to owners and farms that manage competently and efficiently if they use lands inefficiently.

The advantage of american land legislation is also its focus on compliance with the requirements for maintaining soil fertility in any organizational form of land relations. In Ukraine, such mechanisms, neither legal nor economic, that would encourage land users to comply with crop rotation requirements, currently do not exist, as they do not exist in virtually all aspects of careful and environmentally rational use of land and reproduction of soil fertility.

Funding of measures to ensure the functioning of the land management mechanism for the sustainable use of agricultural land comes from the federal budget based on programs via the relevant ministries. It is paid a considerable attention concerning the organization of land management in the United States to the processes of land use planning of areas with certain landscape characteristics: topographic (for example, the level of fragmentation of the territory, location of different types of land, infrastructure, etc.), water, etc. To do it, at the state level, it is used economic methods of land use regulation to protect valuable agricultural land from the irrational withdrawal of them for the acquisition of housing or industrial assets, the organization of construction of non-agricultural facilities. First of all, such methods include the method of preferential taxation of agricultural lands. The idea of the method is to evaluate agricultural land according to their actual use, not market value. Thus, situations where the farmer sells agricultural land for construction, as the latter have much higher market value, will be avoided (Грещук, 2017). It is concentrated on the problem of creating an economic mechanism for regulating soil protection activities in the United States. For example, the strategy of "green" and "red" tickets is widespread in the United States. It encourages farmers who protect the soil from erosion, and provides for a fine through the court for those who violate the established soil protection requirements. Farmers are motivated to mulch and reduces crops of erosion-hazardous crops; they are provided with instructions and projects on environmentally sound organization of the territory and construction of anti-erosion terraces free of charge. In many U.S. counties, as part of a soil protection program, farmers receive $ 25 to $ 30 per acre annually for three years for implementing soil protection technologies (Височанська, 2015).

According to experts, the American experience is so fascinating for Ukraine because Ukrainian land legislation is based on American principles. In this context, the lack of a single national land cadastre, differences in the legislation of each state complicate the American land management system. Another interesting feature of the American experience for Ukraine is a certain economic method of influence, typical of the United States. There are many regulations and prohibitions in Ukraine. In the USA, potential land users who want to change the purpose of the land using a legal requirement should pay significant taxes to the budget (Балюк, Гапєєв, 2016).

The United States has two main levels of government – the federal level and states. In addition, there is no single legislation concerning land use planning and development. Each state elaborates the relevant documents in accordance with its program of development and organization of the territory (Ботезат, 2016).

In the United States, the lease agreement is usually concluded for a year with its subsequent extension. Long-term leases are lucrative for both parties, in terms of soil improvement and pollution control in case of clear legislation. In the USA, farmers benefit from lease if the market value of the land is higher than the lease one. There are three main forms of lease concerning the distribution of income between the parties and the type of lease: fixed cash (cash), the share of crops (crop products) and the share of livestock products. The state regulates lease relations in different ways. Under the laws of many US states, the applicant for the lease of the farm has several requirements related to the availability of agricultural education, professional experience and programs for the efficient use of leased land. It would be quite appropriate to establish these requirements for Ukrainian farmers as well (Коритник, Шпичак, 2009; Торчук, 2007).

In the United States in the 80s, it is introduced a program of soil protection measures "The Conservation Reserve Program" (CRP), the program of preservation, or "reservation" of erosive areas, withdrawing them from cultivation and sowing of perennial grasses for 10-15 years. Funding using land sales tax under the CRP program was provided. The result of this program for 30 years is the preservation of 9 billion tons of fertile soil from erosion, as well as reduced leaching of mineral fertilizers by 85%. The best results in minimizing the effects of water erosion were achieved among the states in Missouri. Another positive result was also achieved – the approximate structure of the land fund was 1/3 of arable land, 1/3 of pastures and hayfields, 1/3 of forestland. This structure using the "reservation" of agricultural lands was achieved. Land reservation was used for certain practical conservation purposes: coastal buffers (zones); buffers for wildlife habitat; buffers for wetlands; filter strips; restoration of wetlands. Due to these measures in the region, it was possible to improve the quality of water resources, increase the population of flora and fauna for the area and generally optimize the ecological environment of the region. The implementation of the CRP program for individual agricultural formations was carried out. It was also adopted a nationwide program for the formation of a national ecological network, which provided for a number of measures: optimization of land areas, reduction of plowing, the introduction of soil protection systems, creation of ecological corridors, and others. (Бутенко, Харитоненко, 2017).

The implementation of the CRP program is carried out for individual agricultural formations (farms) that have voluntarily participated in it. Farmers participating in this program receive land tax benefits. During the implementation of soil protection measures, the available land resources, specialization and future economic development plans are taken into account. The CRP program is divided into subprograms related to certain optimization solutions (Natural Resources Conservation..., 2021; United States Department ..., 2021).

There are alternative ways to use degraded, unproductive and infertile agricultural lands. As an example, in the United States and EU member states, such lands become natural lands. Due to these lands, forest cover is increased, landscape and ecological problems are solved, recreational areas are expanded, non-food crops (poplar, willows, and others) are grown for pulp production, alcohol, starch, as well as plants to obtain aromatic, flavoring and medicinal substances (Дудич, 2016).

Besides, such measures reduce the level of plowing, which is extremely important for maintaining the ecological balance in the environment, as thus the ratio between the area of plowed land, forage, forests and water bodies is close to optimal. There are stabilizing (forage lands, natural meadows, forests, water bodies) and destabilizing lands (arable land, fallow lands) to determine the optimal ratio.

Considering scientific conclusions, it is necessary to withdraw about 10-12 million hectares of arable land from intensive cultivation in order to approach the optimal ratio between these lands and set the rate of plowing in Ukraine at least 40% (the limit set by research), (Сайко, 2011). According to V. Kulinich, the optimal ratio of lands should be established for each of the natural and agricultural areas, which at the present level are the most homogeneous in the natural and climatic aspect of the territory. Unfortunately, today only higher taxa of zoning (zone-province-district) are sufficiently characterized, and it is not time for the natural-agricultural districts due to lack of funding (Ковалевський, Михайлюк, Семенов та ін., 2003).

Taking into account the analysis of foreign experience, the following main measures of land use rationalization in the United States are identified, which we can use in Ukraine (Fig. 2):

- planning of basic measures to ensure sustainable land use is carried out at the state level in the context of the approval of special programs on environmental protection, conservation and protection of agricultural land, and others;
- planning of environmental, anti-erosion, reclamation, water regulation measures, and others;
- support for agricultural producers (farmers) to increase the efficiency of their main activities, and compliance with the principles of soil protection and rational land use in farms.

- implementation of land organization of territories with certain landscape characteristics: topographic (for example, the level of fragmentation of the territory, location of different types of land, infrastructure, and others), water, and others.
- use of economic methods to regulate land use to protect valuable agricultural land from the irrational withdrawal for the acquisition of housing or production facilities, the organization of construction of non-agricultural facilities (method of preferential taxation of agricultural lands.
- absence of legislation as to planning and development of land use of the state, as each of them develops its programs of development and organization of the territory (they are developed by special departments called the Planning Office).

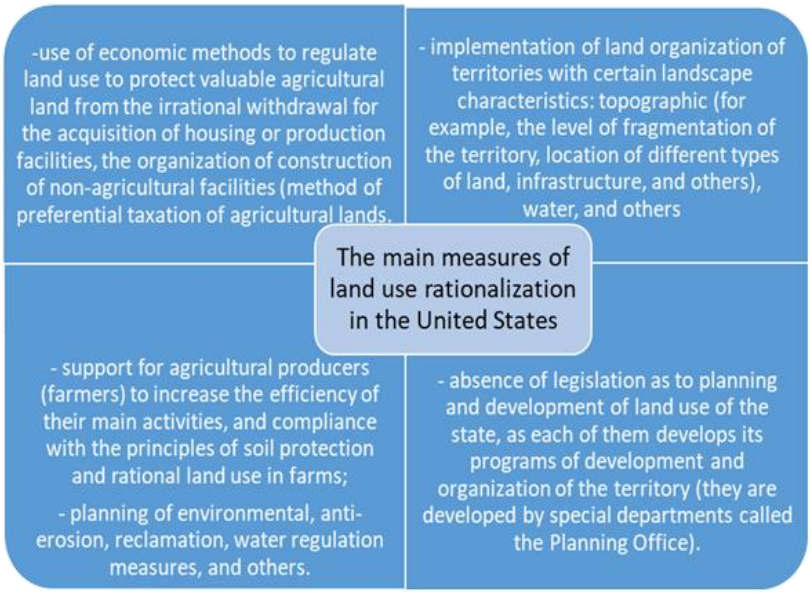

Fig. 2. The main measures of land use rationalization in the United States (results of the analysis of the American experience). (Source: author's development).

The USA uses a wide range of methods and measures to rationalize land use. These include strict bans and penalties, as well as economic methods of incentives, taxation and financial support for businesses. There is also a wide variety of land protection and management programs at various levels in the United States. The US experience should be implemented in controlling the ecological condition, intended use and other quality characteristics of agricultural land for the improvement of land use regulation in Ukraine.

Conclusions and proposals

Concluding the above-mentioned results of the analysis of the American experience of land use regulation, this country uses a wide range of methods and measures to rationalize land use.

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DOI: 10.22616/j.balticsurveying.2021.15.003

IMPACT OF TECHNOLOGICAL CHANGES IN LAND MANAGEMENT AND GEODESY ON LAND SURVEYING HIGHER EDUCATION IN UKRAINE

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Abstract
The article shows that the rapid technological changes in the field of topographic, geodetic and cadastral activities that have occurred in recent decades, significantly affect the nature and content of work to be performed by future engineers in the field of geodesy and land surveying. The directions of adaptation of the content of geodetic and land surveying education to the needs of the national and world market of engineering services are considered. Global navigation satellite system (GNSS), laser 3D-scanning and operational mapping using unmanned aerial vehicles will have a decisive impact on the development of the industry in the near future. Paper maps are being replaced by multimedia devices that display dynamic map content tailored to a specific consumer. During the study, the student must get acquainted with all the most advanced technologies that will determine the future of the industry in the medium term to be ready for their practical application. A modern university lecture should be designed so that the student can hear only what he or she cannot find on the Internet. The aim of the article is to try to comprehensively generalize and analyze global trends and prospects for the development of topographic and geodetic, cadastral, registration and evaluation activities, as well as to determine on this basis the adaptation of geodetic and land management education to the needs of national and global engineering services.
Key words: geodesy, land surveying, higher education, cartography, cadastre, real estate appraisal, geographic information systems.

Introduction

In recent decades, the world has undergone extremely intensive development of new technologies for obtaining information about the spatial characteristics of objects on the Earth's surface, including remote sensing, satellite navigation, geographic information modeling, artificial intelligence and more. Continuous informatization covered the field of cadastral and registration activities, land surveying and real estate appraisal. The consequence of this "scientific and technological revolution" is, among other things, dramatic changes in the labor market, because the engineering skills and abilities of geodesists, land surveyors, photogrammetrists, cartographers, which twenty years ago could be considered very popular, today quickly "become obsolete" and lose topicality.

In the largest "risk zone" are students of higher education institutions studying in "Geodesy and Land Surveying". After all, higher education in Ukraine, unfortunately, is characterized by a certain "inertia", and many universities, not having the technical and human capacity to offer training courses based on advanced technologies and technical means, continue to use openly outdated curricula.

Further neglect by universities of the fact that the national and global market for engineering services are changing incredibly fast, and with it the demand for skills and competencies of employees, may have only one consequence - discrediting institutions such as higher education, because modern youth who have access to global information networks, can easily distinguish between the provision of truly relevant knowledge and dogmatic simulation of the educational process.

Thus, an important task for higher education is a systematic analysis of trends in which geodesy and land surveying will develop in the coming decades, as well as the development of training and retraining programs that will allow them to remain competitive in domestic, European and global labor markets.

Despite the fact that the content of land surveying and geodetic education in Ukraine is devoted to many works of domestic researchers, in particular, D. Hnatkovych, O. Panchuk (Гнатковичˌ Панчук, 2001), A. Tretiak, V. Krivov (Третякˌ et.al, 2001), O. Lozovy (Лозовий, 2009), M. Stupen, R. Gulko, R. Taratula (Ступеньˌ et.al, 2009), J. Dorosh, Z. Flekey (Мартинˌ et.al, 2009), D. Dobryak (Добряк et.al, 2013), and others, they focus mainly on the problems of compliance of the content of education with the urgent task of long-term land reform in Ukraine. However, a systematic analysis of global and regional perspectives and trends in the technological development of geodesy, land surveying, spatial planning, cadastral and evaluation activities is practically not carried out.

At the same time, there is an active discussion on the future of land management education within the framework of the commission "Professional Education" of the International Federation of Surveyors

(FIG). It is worth noting the works of F. Masum, E. M. C. Groenendijk, R. Mansberger, A. Martin, (Masum et.al, 2017), B. Marcus (Marcus, 2004), S. Enemark, P. Cavero (Enemark, Cavero, 2003), and others.

Methodology of research and materials

The methodology of studying the problem of higher education in geodesy and land surveying determines that the subject of the study is the adaptation of the content of geodetic and land surveying education to the needs of the national and world market of engineering services. For this purpose the analysis and generalization of global trends and prospects of development of topographic-geodetic, cadastral-registration and appraisal activity, and also definition on this basis of directions of adaptation of geodetic and land surveying education to needs of the national and world market of engineering services is carried out. In modern conditions, one of the ways to outline the prospects for the development of geodesy and land surveying can be a comprehensive analysis of program and working documents of leading professional international institutions, such as EuroGeographics, Council of European Geodetic Surveyors, European Land Registry Association, EuroSDR, Association of Geographic Laboratories in Europe, International Cartographic Association, International Society for Photogrammetry and Remote Sensing, Open Geospatial Consortium, UVS International, US Defense Advanced Research Projects Agency (DARPA), etc.

Discussions and results

According to one of the world's leading futurists, Prof. Michio Kaku, in order to achieve real success in the future, it is necessary to develop those abilities that are not available to works: creativity, imagination, initiative, leadership qualities. Society is gradually moving from a commodity economy to an intellectual and creative. There is a much better chance of success in those countries that will be able to balance product markets and cognitive and creative potential. In turn, nations that believe only in agriculture will not last long and are doomed to poverty.

There is no doubt that applicants closely monitor the labor market. In this regard, we quote the decision of the international conference on European professional qualifications in land management, organized by the FIG and CLGE, held in Brussels in 2005: "the profession of surveyor across Europe emphasis on geodesy and measurement to the science of space and land surveying dealing with land rights, restrictions and encumbrances, in which property systems and legal issues become key elements". We cannot disagree with these conclusions, because in a few years the current land surveyors will be faced with the task of preparing project decisions on agricultural land consolidation, developing comprehensive spatial development plans, forming land use restrictions, integrating data from various cadastral systems, and servicing real estate market, etc.

Interest in higher education in geodesy and land surveying continues to grow every year. Specialists in this specialty are becoming increasingly popular not only in the field of land relations, but also in the agricultural sector, construction, transport, military, energy, mining and more. Currently, the number of universities that train specialists in "Geodesy and Land Surveying" in Ukraine is more than four dozen. Applicants for higher education in times of rapid development of new technologies and business models, artificial intelligence systems, robotics processes and the gradual disappearance of a number of professions, must master advanced technologies for obtaining and processing geospatial data, be able to compile all types of land surveying documentation, confidently solve land and property problems their future customers, to be mobile, purposeful and confident professionals.

Given the above, we will try to model the main trends in geodesy and cartography, land management, geoinformatics, remote sensing, cadastral registration and evaluation activities, as well as management in the field of land relations, which determine the modernization of geodetic and land surveying education.

Geodesy

Construction, transport, agriculture, environmental protection, public administration and national defence will continue to require the surveying industry to ensure reliable and accurate global, regional and local three-dimensional positions of various objects, determining the geometry of the earth's surface, sea and glaciers, variable gravitational field etc. Society needs low-cost, reliable, fast, high-precision real-time positioning with well-defined dates and minimal restrictions.

At the same time, a kind of "revolution" in topographic and geodetic activities in recent decades has been caused by three technologies: global navigation satellite system (GNSS), laser 3D-scanning and

operational mapping using unmanned aerial vehicles. It is obvious that these technologies will continue to have a decisive impact on the development of the industry in the near future.
GNSS technology made positioning cheap, massive and fast. The lidar technology, which combines laser distance measurement, computer, inertial measurement and differential GNSS into an integrated instrument, has made a huge breakthrough in 3D spatial information and is the most advanced means of obtaining high-quality real-time geospatial data. This is an extremely promising and advanced technology that makes a revolution in geodesy and cartography, environmental monitoring, 3D modeling of the urban environment, oceanography, geology, archeology, etc.
Measurement and aerial photography of land, carried out by unmanned aerial vehicles, today is the most relevant and cost-effective solution for most tasks in the field of geodesy and topography. unmanned aerial vehicles provide accurate and reliable photos and videos about the features of the terrain for agriculture and construction, perform aerial laser scanning, conduct geological surveys, monitoring of buildings and structures and more.

Cartography

Today, paper maps are being replaced by multimedia devices that display dynamic cartographic content adapted to a specific consumer.
The future of cartography will be determined by the following trends: real-time cartography; everyday use; media adequacy; personalization; excellent visualization. The main idea of web mapping is to create a global, open, interactive, multi-purpose online infrastructure that works in "real time" and is based on close collaboration between governments, academia and, most importantly, ordinary people. united (or not united) in online communities, non-governmental organizations, movements, etc.
At the moment, the global infrastructure of mass web cartography is developing rapidly and has a decentralized, multi-layered architecture, which combines both global (Google Maps, Open Street Map, Bing Maps) and local (Sudan Satellite Sentinel Project, CERA, Yandex.Maps) services of wide and crisis (Development Seeds, Citivox, Tomnod) purposes, which can be both proprietary and non-commercial.
The most promising technologies in the industry: web cartography, 3D maps, map personalization, integration with social services, augmented reality.

Geographic information systems

Thanks to GNSS, RFID and modern GIS, the time has come when you can find out where any object is. This will allow a revolution in entire industries, when the location of each vehicle, each farm animal, each commercial flight, each mobile phone, each bank card, etc.
GIS is confidently becoming a real-time system. Previously, the process of creating a map was quite long, and therefore, traditionally, it was applied to the most permanent features of the earth's surface: roads, rivers, mountains, streets. However, over the past two decades, the widespread use of GNNS and mapping software has changed this rule. Neogeography has become a new trend: the ability to create personal maps, personal reflections that may be of interest only to a particular consumer and only for a short time. For example, thanks to a smartphone with a GNSS-navigator, a modern driver sees "traffic jams" and the optimal route in real time.

Cadastre

The main factors that will affect the development of cadastral systems include: globalization, urbanization, e-government, climate change, the needs of nature management, 3D-visualization and analysis technologies, standardization, interoperability. The most promising concepts of the cadastre of the future should be considered: accurate cadastre (virtual cadastral models will be closer to the real situation); object-oriented cadastre (the object of accounting is not land, but property); 3D / 4D inventories (inventories will include the third (height) and fourth (time) dimensions); real-time inventories (changes to inventories and access to them will take place online); global cadastres (national cadastres are gradually transformed into a global cadastral network); organic cadastres (cadastres will be adapted to take into account the uneven or fuzzy boundaries of natural objects) (Bennett et al., 2010).
In terms of technological trends, cadastral systems of the future will have the following features:
- the third dimension of landscape and objects will be taken into account, which today sometimes goes beyond the existing legal framework;
- the cadastre will combine a strategic and dynamic map to show the historical evolution of land use;
- the cadastre will be multifunctional and will serve many jurisdictions;
- the cadastre will be deeply integrated with social networks;
- the objects of cadastral accounting will be new entities, about which we may not yet know;
- the cadastre will become an important element of the society of knowledge.

Promising technologies of cadastral registration activity should be considered:
- model of public land use (STDM) (project approach that allows to record non-traditional forms of land use);
- point cadastre (fast cadastral approach, which captures a single coordinate (potentially captured using portable GNSS) to represent the plot, rather than a complete set of surveyed boundaries) (Antwi et al., 2012);
- use of "digital pen" (a tool that significantly reduces the process of transcription of field data, thereby reducing errors and speeding up recording time);
- crowdsourcing cadastre or "Cadastre 2.0" (an approach in which citizens learn to make decisions on demarcation, search and registration of the border, using inexpensive processes and mobile technologies);
- use of high-resolution satellite imagery (HRSI) to quickly establish boundaries and map rural areas;
- use of low-altitude remote sensing (LARSI) (images taken by light or unmanned aerial vehicles equipped with a camera, GNSS receiver and other positioning tools).
Significant potential for implementation during the registration of real property rights is characterized by blockchain technology, which provides distributed storage of a chain of transaction blocks, protected from counterfeiting and processing. Each block contains a timestamp and a reference to the previous hash tree block. In the long run, this technology can eliminate the state from performing the function of a guarantor of real property rights, but there are also important reservations about its possible use. In Ukraine, despite the widely announced "transfer of cadastre to blockchain", only certain elements of the technology were actually used during the issuance of extracts from the State Land Cadastre, and the cadastre database itself was not translated or distributed in the public domain.

Evaluation activities

In the next decade, we can expect a "big reset" of valuation activities. The main driver of change will be the automation of valuation and the widespread use of computer models in real estate valuation, based on automated monitoring and forecasting of the market environment, as well as neural network technologies, Big Data and Deep Learning. A promising source of information for property valuation is the use of social networks.
We can expect a gradual transition of professional real estate appraisers to other niches, such as working as financial analysts, portfolio management and investment analysis, tax consulting or litigation.

Land surveying and spatial planning

Assessing the technological prospects for land development and spatial planning is usually the most difficult, given that this area is quite conservative and relies heavily on established local traditions, regulations and design approaches.
It can be expected that promising technologies of spatial planning should be: extended spatial analysis; multi-agent systems; spatial optimization models; system dynamic models; creation of virtual worlds; new methods of visualization. We should also expect wider use of web services in spatial planning, as well as the use of crowdsourcing in this area, when the design decision will not be the result of the author's idea of a particular design engineer, but a joint achievement of the local community. territories through web interfaces of various public discussions and social networks.
It will be necessary to take into account the economic consequences of spatial planning as much as possible, because designers often forget that every project decision to change the function of the territory or land use restrictions has very specific consequences for changes in land values, the need for further expropriation of private real estate.

Administration of land relations

Due to the fact that geodetic processes of demarcation of borders due to scientific and technological progress and the latest positioning technologies become simpler and no longer require significant labor costs, many researchers note an important trend to change the function of the future land surveyor from the usual surveying to address a much wider range of land relations administration issues.
Analyzing the program documents of international organizations on the current tasks of land management, we can note the following areas where the most in demand qualified knowledge and skills of land surveying specialists:
- managing conflicts related to access to land resources caused by global migration flows, climate change, military conflicts;
- management of public lands;
- expropriation of land in the public interest;
- regulation of the transfer of rights to real estate, sale, lease of real estate;

- real estate taxation system and its optimization (property taxes);
- organization of mortgage lending;
- e-government and public services in land relations;
- overcoming poverty on the basis of responsible land management.

Education in the field of land administration should be almost entirely based on practical examples and real-life situations. Obviously, a teacher who tells students about the "theoretical basis of land management" simply cannot tell them anything of practical value.

What conclusions can be drawn when it comes to improving modern land surveying and surveying education? First of all, training will no longer be based on memorization and personal contact, and online education and self-education will become the main competitors of universities, which will lose the monopoly on qualifications, as employers will assess specific skills and competencies rather than diplomas.

Mass online education is becoming a reality today, and modern technology makes university education available regardless of place of residence - whether a small village in Polissya or the west coast of the United States.

A typical example is the Coursera project, which involves professors from Stanford University, the California Institute of Technology, Princeton University and other leading universities. Anyone here can get free access to video recordings of lectures from any of the proposed training courses, which are currently more than four hundred: "social psychology", "machine vision", "introduction to sociology", "geoinformatics" and more. So far, more than 10 million people from all over the world, including Ukraine, have signed up for Coursera. It is clear that when a course of lectures is given to you by a Nobel laureate, the value of the information is much higher than the lecture of a sad and low-paid associate professor from a provincial institute. In order for graduates of educational institutions in the field of "Geodesy and Land Surveying" to become in demand and highly paid professionals, the following principles should be followed:

- at least 80% of training should be dedicated to what will be tomorrow, not what was yesterday;
- the university must teach the student to think critically, to be intellectually mobile;
- a modern university lecture should be designed so that the student can hear only what he can not find on the Internet;
- during the study the student must "touch" all the most advanced technologies that will determine the future of the industry in the medium term to be ready for their practical application;
- practical training should be built so that the student can start his own business.

The land surveying faculty of a modern higher education institution should no longer be just a training center. It should become an intellectual and expert-analytical center of the industry, a platform for testing and practical adaptation of advanced technological solutions, a platform for professional discussions and practical training - only such an approach will preserve domestic land surveying education in the medium term and count on international recognition.

Conclusions and proposals

In the next decade, topographic and geodetic activities, cadastral activities and spatial planning are expected to undergo dramatic changes, the main features of which can be observed today. The world economy will need cheap, high-tech and fast engineering solutions that can only be provided by properly trained professionals with critical thinking and good knowledge. Universities must, of course, adapt to the needs of the national and global labor market, offering curricula based on advanced technologies and best industry practices.

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DOI: 10.22616/j.balticsurveying.2021.15.004

GEOSTATISTICAL APPLICATION FOR SPATIAL DISTRIBUTION OF WATER SUPPLY FACILITIES TOWARDS ACHIEVING THE UNITED NATIONS' SUSTAINABLE DEVELOPMENT GOALS

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Abstract
Geostatistical tools are considered to be very imperative in achieving the Sustainable Development Goals (SDGs), most especially in the distribution of facilities. Studies on the application of geostatistics such as Average Nearest Neighbour (ANN) in the spatial distribution of sustainable water supply facilities are often very rare. This study, therefore, explores the critical importance of the ANN analytical tool of ArcGIS to examine the spatial distribution of public water supply facilities in Lapai, Nigeria. The ANN sets the null hypothesis that there is no difference between the random distribution and the distribution of public water facilities in the study area, where the z-score and p-value results are both measures of statistical significance which explains whether the null hypothesis should be accepted or rejected. The results obtained indicate a similar spatial distribution pattern for all water facilities in the study area, as they are dispersedly distributed from the global view. The method will allow more proactive decision making in the provision of sustainable public water supply facilities to better the wellbeing of urban dwellers.
Keywords: Geostatistics, Average Nearest Neighbour, Public water facilities, Sustainable Development Goals, Spatial distribution

Introduction

The United Nations (UN) during the September 2015 general assembly attended by head of states and representatives of 193 member states agreed to adopt the 2030 Agenda for Sustainable Development consisting of 17 goals and 169 targets – the Sustainable Development Goals (SDGs) (UN, 2015). The new global sustainable goals require major efforts in conducting and monitoring its progress (Giupponi, Gain, & Farinosi, 2018). Thus, experts from various professions proposes techniques in achieving and monitoring the progress of the SDGs most especially geospatial and geostatistical techniques (Avtar, Aggarwal, Kharrazi, Kumar, & Kurniawan, 2020; Josepha, Gething, Bhatt, & Ayling, 2019; Onwe, Nwankwor, Ahiarakwem, Abraham, & Emberga, 2020). Geospatial technique with the aid of Geographic Information System (GIS) provides 'the right information on the right things and at the right time' where geospatial data, adequate technology, and management systems complement high-quality official statistics (UN, 2015). These techniques need to be available quickly enough to ensure that the data cycle matches the decision cycle (Andres et al., 2017; Choudhury, Maria, & Meggiolaro, 2018; Giupponi & Gain, 2017). For example, UN-Habitat (2016) suggests that if data for the SDGs goals and targets were collected and represented using geospatial and geostatistical data, this would significantly enhance understanding of the spatial determinants of sustainable development, including the urban and rural patterns of progress.

Geostatistical tools such as ANN have a wide range of applications across various sectors. ANN was employed by Aghadadashi (2019) while examining the spatial structure of sedimentary total Polycyclic Aromatic Hydrocarbons (PAHs) and potential eco-risks to explore the suitable lag size. When assessing geographical analysis of the distribution and spread of human rabies in China, Guo et al. (2013) used ANN where it suggests that the number and duration of cluster decreased significantly after 2008. Hazrin et al. (2016) examined the spatial distribution of dengue incidences where it was argued that spatial statistical analyses are important in guiding health agencies, epidemiologists, public health officers, town planners, and relevant authorities in developing efficient controlmeasures and contingency programmes in identifying and prioritizing their efforts in effective dengue control activities.

Using the ANN tool of the spatial statistics toolbox of ArcGIS 10.3, Javari (2016) examined the temporal-spatial distribution of the precipitation station locations. Also, using ArcGIS 10.2, Li et al. (2019) examined rural settlements to identify whether the distribution of the rural settlements is clustered or dispersed in order to achieve village regrouping in the eastern plains of China where ANN is seen as the best technique. Furthermore, Mansour (2016) studied the spatial pattern of the distribution of public

health facilities across Riyadh governorate, Saudi Arabia using ANN where ANN was recommended as one of the best methods in analysing spatial pattern. Studies on spatial distribution of sustainable water supply facilities using ANN geostatistics are often very rare.

The SDG 6, which is on water and sanitation, provides the targets and indicators for monitoring progress towards universal and equitable access to safe and affordable drinking water and to adequate and equitable sanitation and hygiene (WHO, 2016; UN Water, 2018). This goal has attracted several studies and approaches in attempts to enable and accelerate progress towards achieving the goal and its targets (Mycoo, 2018; Ortigara, Kay, & Uhlenbrook, 2018; Park, 2018). For instance, Hall, Ranganathan & Raj Kumar (2017) focuses on how multiple-use water services (MUS) approach to SDG 6 could reinforce a wide range of other SDGs and targets by developing modeling framework. Mycoo (2018) analyses water governance challenges in meeting SDG 6 where it proposes policies, good practices, and tools to confront growing threats to water security and to attain sustainable development. While focusing on education, training, and research and how they could contribute to enabling and accelerating progress towards achieving SDG 6, Ortigara et al. (2018) also addresses countries reports and frameworks.

Most of the past studies were limited to frameworks, policy guidelines, country reports, and good practices while only a few focuses on tools and techniques most especially geospatial techniques in achieving SDG 6 (Cole, Bailey, Cullis, & New, 2018; Vanham et al., 2018). The few that focus on geospatial techniques also ignore geostatistics most especially the Average Nearest Neighbour (ANN) analysis. The ANN has capabilities for examining the distribution pattern of items on space amid its wide application (Aghadadashi et al., 2019). ANN has been applied to analyse health facilities (Mansour, 2016), diseases (Hazrin et al., 2016), precipitation variation (Javari, 2016), village regrouping (Li, Liu, Chen, Li, & Yu, 2019), seismic surveys (Trevisani, Boaga, Agostini, & Galgaro, 2017) and other applications that have to do with clustering among locations (Wilson, 2018). From the previous studies, applications of ANN in assessing the spatial distribution of sustainable water supply facilities are often very rare or ignored. It is on this backdrop that this study explores the critical importance of the ANN analytical tool of ArcGIS to facilitate the spatial distribution pattern of public water supply facilities in Lapai, Nigeria and accelerate progress towards achieving the United Nations' SDGs (specifically SDG 6) in the area.

Methodology of research and materials

Study Area

Lapai is located within latitudes 9°1'40" and 9°4'10" North of the Equator and longitudes 6°32'30" and 6°34'10" East of the Greenwich meridian. Lapai is a medium town and covers an area of 3,730 Km^2 with an estimated population of 12,859, based on the census of 2006 (NPC, 2006). The town is about 56 Km East of Minna, Niger State Capital. Lapai Local Government Area of Niger State is situated in a rural setting, and the major occupation of the people is farming. Few are either employed in white-collarr jobs or involved in private businesses. The locational map of the study area is shown in Fig. 1.

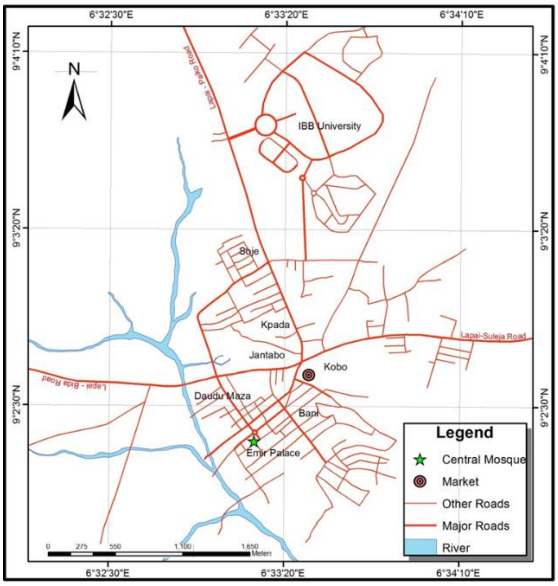

Fig. 1. Lapai Town in Niger State of Nigeria
Source: Ministry of Lands and Housing, Minna (2018)

Data and Materials

The locational position of water supply facilities in terms of X and Y coordinates were taken using hand-held GPS before further analysis, to provide detail information on the nature and condition of the existing facilities. The coordinates were taken in Universal Traverse Mercator (UTM) using handheld GPS (Etrex 10). The total number of public water supply facilities found in the study area was 45 which includes 2 taps, 26 motorised boreholes, 13 hand pump boreholes and 4 wells (see Fig. 2). There are other features on the map, some of which belong to the water agency (Niger State Water Board) which includes the Water Board, main source, and water storage tank. However, data needed for ANN analysis such as the motorised boreholes, hand pump boreholes and wells were collected with the exception of public taps because they were not functional.

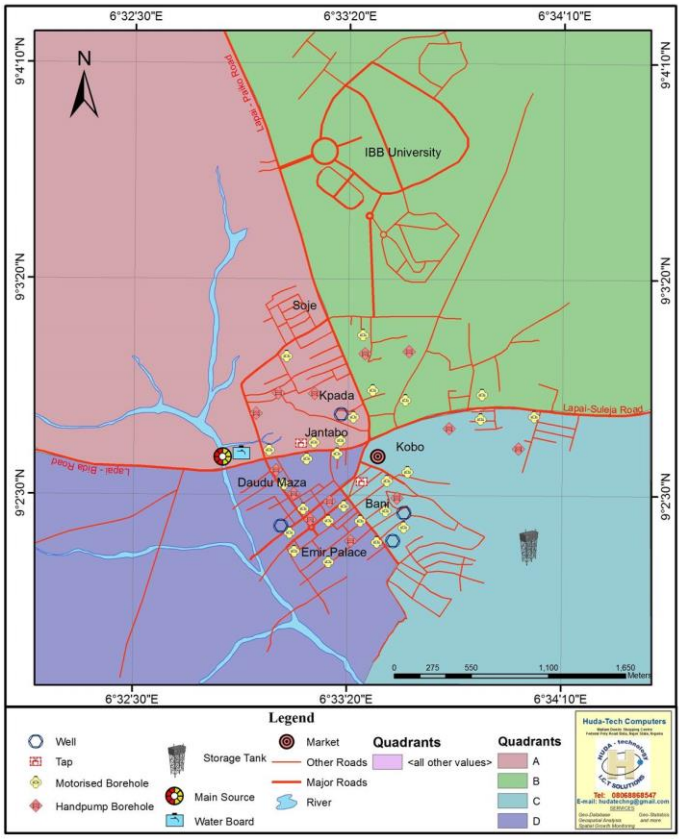

Fig. 2. Lapai Town Showing Location of Public Water Facilities
Source: Authors' fieldwork, 2018

Analysis

ANN Analysis tool was adopted in measuring patern of spatial distribution pattern of water supply facilities in the study area. The ANN ratio is given as (Mitchell, 2005):

$$ANN = \frac{\overline{D}_O}{\overline{D}_E} \tag{1}$$

where $\overline{D}_O$ is the observed mean distance between each feature and its nearest neighbor:

$$\overline{D}_O = \frac{\sum_{i=1}^{n} d_i}{n} \tag{2}$$

and $\overline{D}_E$ is the expected mean distance for the features given in a random pattern:

$$\overline{D}_E = \frac{0.5}{\sqrt{n/A}} \tag{3}$$

In the above equations, d_i equals the distance between feature i and it's nearest neighbouring feature, n corresponds to the total number of features, and A is the area of a minimum enclosing rectangle around all features, or it's a user-specific Area value.
The ANN z-score for the statistic is calculated as:

$$z = \frac{\overline{D}_O - \overline{D}_E}{SE} \tag{4}$$

where:

$$SE = \frac{0.26136}{\sqrt{n^2/A}} \tag{5}$$

The ANN sets the null hypothesis that there is no difference between the random distribution and the distribution of public water facilities in the study area, where the z-score and p-value results are both measures of statistical significance which explains whether the null hypothesis should be accepted or rejected.

Discussions and results

Average Nearest Neighbor Analysis is a method/tool used to explore and explain the spatial distribution of public water supply facilities. The tool sets the null hypothesis that there is no difference between a random distribution and the distribution of public water supply facilities in the study area (see Fig. 3 – 5 and Tables 1 – 3). Although, public tap facilities are not considered in these spatial statistical results due to limited and non-functioning of those facilities.

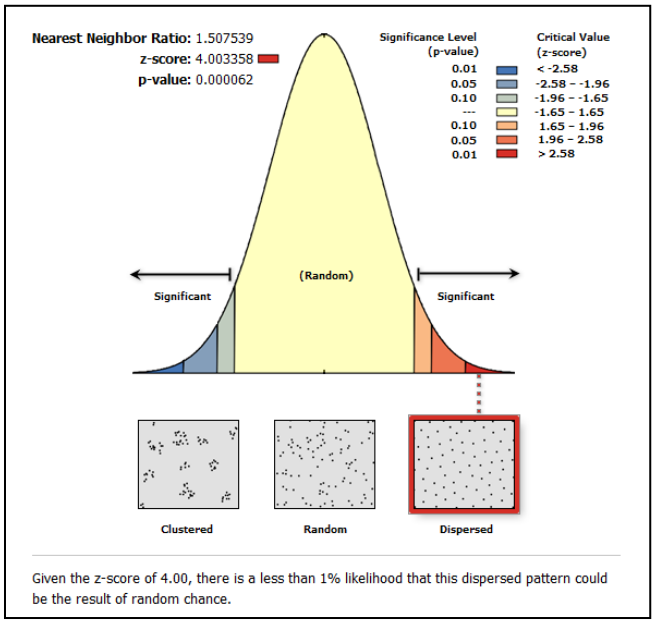

Fig. 3. Spatial Distribution of Public Hand Pump Borehole in Lapai Town
Source: Authors' fieldwork, 2018

Table 1

Average Nearest Neighbor Analysis Summary of Public Hand Pump Borehole in Lapai Town

Observed Mean Distance	**820.541468**
Expected Mean Distance	544.292172
Nearest Neighbor Ratio	1.507539
z-score	4.003358
p-value	0.000062
Input Feature Class	Handpump Borehole
Distance Method	EUCLIDEAN
Study Area	20145269.833852

Source: Authors' fieldwork, 2018

Fig. 3 and Table 1 are the outcomes of the global view spatial cluster test of public hand pump borehole facilities. When examine the p-value of 0.000062 and given the z-score of 4.003358, the pattern does not appear to be significantly different than dispersed. Therefore, reject the null hypothesis that all public hand pump borehole facilities are randomly distributed in a global view. However, by re-examining the public hand pump borehole facilities map in Local View, find out that some of the public hand pump borehole facilities are dispersed in locally limited areas.

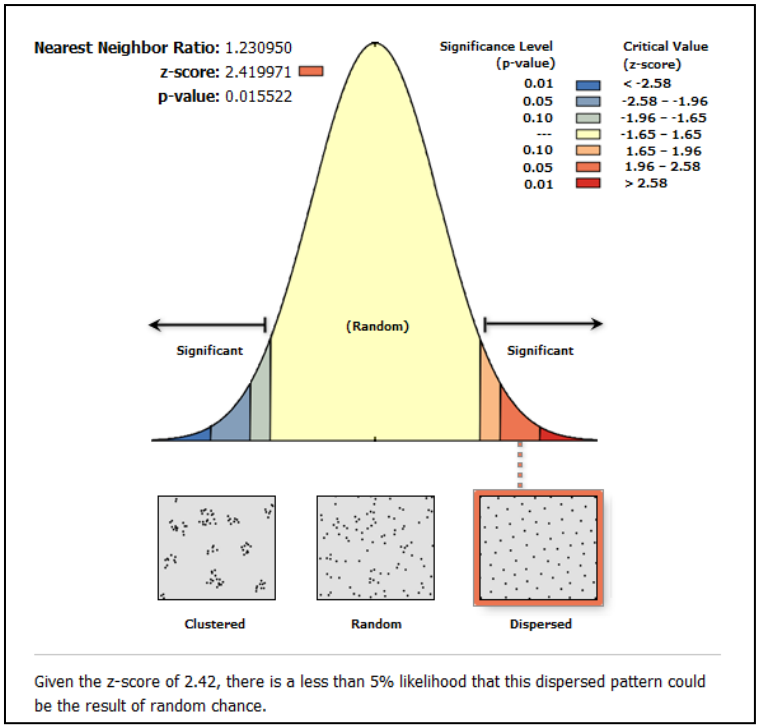

Fig. 4. Spatial Distribution of Public Motorised Borehole in Lapai Town

Source: Authors' fieldwork, 2018

Table 2

Average Nearest Neighbor Analysis Summary of Public Motorised Borehole in Lapai Town

Observed Mean Distance	**505.942337**
Expected Mean Distance	411.017644
Nearest Neighbor Ratio	1.230950
z-score	2.419971
p-value	0.015522
Input Feature Class	Motorised Borehole
Distance Method	EUCLIDEAN
Study Area	20145269.833852

Source: Authors' fieldwork, 2018

Fig. 4 and Table 2 are the outcomes of the global view spatial cluster test of public motorised borehole facilities. When examine the p-value of 0.015522 and given the z-score of 2.419971, the pattern does not appear to be significantly different than dispersed. Therefore, reject the null hypothesis that all public motorised borehole facilities are randomly distributed in a global view. However, by re-examining the public motorised borehole facilities map in Local View, find out that some of the public motorised borehole facilities are dispersed in locally limited areas.

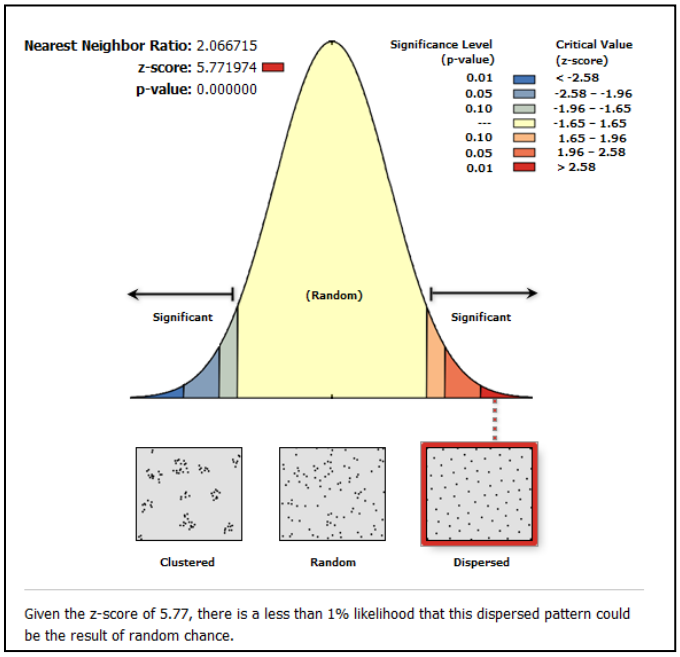

Fig. 5. Spatial Distributions of Public Well Facilities in Lapai Town
Source: Authors' fieldwork, 2018

Table 3

Average Nearest Neighbor Analysis Summary of Public Well Facilities in Lapai Town

Observed Mean Distance	**1631.841318**
Expected Mean Distance	789.582058
Nearest Neighbor Ratio	2.066715
z-score	5.771974
p-value	0.000000
Input Feature Class	Well
Distance Method	EUCLIDEAN
Study Area	20145269.833852

Source: Authors' fieldwork, 2018

Fig. 5 and Table 3 are the outcomes of the global view spatial cluster test of public well facilities. When examine the p-value of 0.000000 and given the z-score of 5.771974, the pattern does not appear to be significantly different than dispersed. Therefore, reject the null hypothesis that all of public well facilities are randomly distributed in a global view. However, by re-examining the public well facilities map in Local View, yet, there are few public well facilities in the study area and that some of the public well facilities are dispersed in locally limited areas. This is similar to the previous results of hand pump borehole and motorised borehole.

The pattern of all water supply facilities in the study area is dispersedly distributed from analysis of the ANN. This can be better explained with large data most especially of water supply facilities. As explained earlier, it can be argued that ANN is one of the best tools in examining the spatial pattern of urban public water supply facilities and also can aid the achievement of the SDGs most especially 'the water SDG' (i.e., SDG 6). This has been argued earlier by Mansour (2016) and Hazrin et al. (2016) that ANN is the best tool for examining the spatial pattern of both health facilities and disease in terms of urban, rural, and regional basis.

Conclusions and proposals

The study has shown that by adopting ANN geostatistics in examining the spatial distribution pattern of public water supply facilities; it will facilitate the achievement of the SDGs by enhancing; safe, affordable, and sustainable water facilities provision. This study has proven that it can be more beneficial in developing countries, especially African nations in formulating policies, programs, and frameworks. ANN geostatistical application is therefore recommended for SDGs for meeting its SDG 6 target before the year 2030. ANN application can also be extended to other aspects of SDGs to study or analyse the distribution of spatial data and phenomenon that can contribute to the achievement of the goals in all countries particularly in developing countries where the settlement pattern is complex, largely informal and difficult to provide infrastructure and services. Yet, Africa can benefit from this approach in formulating policies, programs, and frameworks at country, state, and settlement levels to achieve the SDGs most especially the SDG 6. The tool will allow more proactive decision making in the provision of sustainable public water supply facilities to better the wellbeing of urban dwellers.

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DOI: 10.22616/j.balticsurveying.2021.15.005

EVALUATION AND DEVELOPMENT POSSIBILITIES OF RECREATION AREAS AND TOURISM OBJECTS IN LITHUANIA

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Abstract

The aim of the article is to assess tourism and recreation resources and possibilities of their development in the selected areas in Kretinga, Trakai and Kaunas district municipalities.

Natural and separate zones' landscape complexes in Lithuania are favourable for recreation and tourism. Although Lithuania's territory in comparison with other countries is not large, it is characterized by a huge variety of geographical complexes and landscapes. By recreational potential Lithuania surpasses even numerous European countries, which are arranged along the northern coastline. Rivers, lakes and forests constitute 25 % of the total Lithuania's area. Forests, parks, sea, other water reserves, geomorphological structures are aesthetically valuable landscape complexes in the Republic of Lithuania and make up one third of the total area.

Having conducted assessment of the landscape in the selected territories and analysed territory-planning documents of Kretinga, Kaunas and Trakai municipalities with regard to recreation and tourism, it has been identified that although the main kind of recreational activity in the analysed municipalities is educational recreation, tourism infrastructure is not sufficiently developed and there is a shortage of accommodation-providing companies. After assessment of the landscape in recreational objects, it has been noticed that the assessed objects are characterized by high spatial flora variety, prevailing greenery and plants. In addition, landscapes are varied and not fully adjusted to recreation and tourism.

Key words: landscape, recreational objects, assessment.

Introduction

Due to rapid globalization, the society and its values change as well. The speed of life is becoming more rapid; work productivity and information flows are increasing too. Therefore, people suffer more tension and stress and, thus, the issues of recreation and tourism are becoming more relevant. Recreation zones are mostly found within protected territories or nearby. Protected territories are land or water zones with clear boundaries, which have the acknowledged scientific, ecological, cultural and other value, for which special protection and use procedure is applied (Pankauskyte et al., 2019).

Development of this activity is important for different age groups, families and communities. Each individual perceives recreation differently: for some it is walk in nature, for others it is riding a bike, jogging, climbing mountains or various games, swimming, etc. Experience abroad shows that recreation and tourism make a positive impact on physical and spiritual individual's well-being, help relax and reduce tension.

The topics of recreation and tourism are analysed by numerous Lithuanian and foreign authors since the issue is very important in today's society due to increase of the population and inhabitants' needs. According to Riepšas et co. (2012) recreational resources include natural resources (forests, green areas, water reservoirs, their banks, which are adjusted to people's rest and entertainment, reservoirs of mineral water and applied mud, objects of natural heritage), objects of cultural heritage (real estate values), buildings and objects of tourism and recreation infrastructure found in resorts, recreation and protected territories, touristic routes, observation towers and other territories designated for recreation.

According to Beržanskienė (Beržanskienė et al., 2015) recreation and entertainment concepts are not identical: we could define leisure as the time during which we do not work whereas recreation could be indicated as the content of one's leisure. USA authors C. Goeldner and J. R. Brent (2009) describe tourism as the result of purposeful interaction between tourists, tourism organizations and service companies as well as hosting administration and company in certain environment. In the law of the Republic of Lithuania "On Approval of Recreation Territories Use, Planning and Protection Regulations" it is stated that recreation territories are defined within the general plan of Lithuania's territory, in general plans of state territory parts, municipalities or their parts, tourism and recreation schemes, in general plans of national parks and their zones, biosphere reserves and their zones as well as other documents of special territory planning. By implementing strategic planning documents, municipalities solution of general plans of the municipality and its parts, tourism and recreation schemes

at the municipal and local level, other special territorial planning documents establish recreation zones designated for public recreation and rest. In the development of recreation, it is accepted that attention is mostly paid to locations with high recreational potential, i.e., recreational areas of national and regional importance and the zones of their impact (Goeldner et al., 2012). Conditions for recreation and tourism development in Lithuania are favourable, especially in the districts where soil is not fertile enough for intense agriculture. In addition, in Lithuania there are plenty of valuable histories and culture heritage objects (Indriūnas, 2015). Heritage is one of the most significant factors for development of recreation. Abundance of natural and cultural resources allows promoting active rest, cultural, educational, rural and ecological tourism.

The aim of the article is to assess tourism and recreation resources and possibilities of their development in the selected areas in Kretinga, Trakai and Kaunas district municipalities.

Objectives of the article are as follows:

1. to analyse territory planning documents in Kretinga, Kaunas and Trakai municipalities with regard to recreation and tourism.
2. to conduct the assessment of the landscape in the selected recreational objects.
3. to introduce the possibilities of recreation territories' development.

More and more people are annually concerned with the environment where they live and rest. Cities are more and more extending. Less space for public and open areas is left, whereas the city is planned regarding urban elements without paying enough attention and creative potential to areas (Piekienė, 2015). Growing attention to protection of nature and preservation of biodiversity all over the world encourages to establish new protected territories, to maintain the state of current territories and increase forest cover (Juknevičiūtė, 2012). The most valued and picturesque territory of each country, i.e. country's pride and input into protection of world heritage is found in protected areas. Lithuanian system of protected territories includes a wide range of protected territories for both protection of landscape and biodiversity as well as preservation of natural and cultural heritage (Sakalauskaitė, 2010).

Methodology of research and materials

The article uses the methods of scientific literature analysis, object assessment, and data summarizing. Landscape management, recreation and tourism drawings as well as 2014-2020 development plans in the selected municipalities found within the National supervision information system of Lithuania's territory planning documents preparation and territory planning process were used for more detailed introduction of analysed territories and objects. Moreover, assessment of the selected objects was conducted. Pursuing the assessment of the landscape in the selected objects, 3 recreational objects in Kretinga municipality were selected (Kartena mound, Jaurykla park, Prystovai exposure), 4 territories in Kaunas district municipality (Kaunas 5th Fort architectural reserve, Dubrava marsh reserve, Pažaislis architectural ensemble, Kaunas Reservoir Regional park observation point) and 5 objects situated in Trakai municipality (Trakai Vokė Manour, Trakai Island Castle, Užutrakis Manour, Varnikai cognitive trail, Asaidė cognitive trail). The objects were assessed following A. R. Budriūnas and K. Ėringis "Methodology of landscape and aesthetic recreation assessment" (2000). According to A. R. Budriūnas and K. Ėringis assessment methodology, landscape can be assessed in any territory but most and foremost such investigations should be carried out in recreational zones, protected and unique territories, reservoirs of regional and national parks and other areas of important purposes. However, it is emphasized that this methodology cannot be applied in the seaside and sightings of Curonian Lagoon coastline because the sight length is very distant while the view to the sea is the same along the coast. In addition, elements of Curonian Lagoon coastline landscape are only the details of the total coastline view.

Tha data concerning the assessed objects was collected following the pre-designed questionnaire of landscape assessment. The territories visited by a huge number of individuals in the summer were selected for the investigation. By conducting field investigation, the selected territories were assessed by 4 criteria (table 1).

Seasons have impact on the scenery of the territory. This investigation was conducted in autumn when the background is blurred while flora has neither leaves nor blossom. Before undertaking the assessment of recreational objects, they were visited and the point (sight) from which the most spectacular landscape could be seen was chosen. Landscapes were selected in favourable air conditions when there was no fog or strong wind. In addition, no investigations were carried out in the sun. Possibilities of developing recreation territories were defined having analysed general plans of municipalities and conducted interviews with local inhabitants, visitors of objects and employees of protected territories' directions.

Table 1

Criteria for Landscape Assessment

Assessment criteria	Maximum assessment	Short description of the assessment
General impression of the landscape	21	Assessment was conducted following 11 criteria: landscape brightness, transparency, striped shape, planning, colourfulness, seasonal aspects, dynamic contrasts, naturalness, and other characteristics provided in the assessment methodology. Maximum points could be given to colourfulness of the landscape while minimum points could be provided for background brightness.
Relief expressiveness	49	24 criteria were used for the assessment: general landscape hilliness, abundance of hills and slopes, blurred hills and slopes, abundance of hills in the horizon, abundance of valleys and hollows, existence of blurred valleys and hollows, abundance of valley bends, brightness of exposures, and other characteristics as indicated in the assessment methodology. Maximum points could be given for abundance of valleys, hollows and hills in the horizon whereas the minimum points could be provided for their blurriness.
Spatial diversity of flora	58	24 characteristics were used for the assessment: flora, highlighting the relief, trees and herbaceous vegetation, fields in wooded landscape, abundance of different land plant communities, diversity of forest and greenery top line, existence of blurred tree objects, abundance of hills and slopes with wooded tops, brightness of tree lines and stripes along the coast (abundance of separate objects) and other characteristics indicated in the assessment methodology. The most important assessment parts are abundance of solid vegetation on the hills and slopes with wooded tops as well as flora highlighting rivulets and mountains.
Diversity of anthropogenic objects	42	21 criteria were used for the assessment: landscape urbanization, abundance of architectural highlights, relationship between settlements and buildings and the environment, adaptation of agricultural fields, adaptation of engineering equipment, existence of blurred anthropogenic objects, variety of protected natural objects, brightness of mounds and castles and other characteristics indicated in the assessment methodology. Architectural highlights as well as abundance of separate buildings collect the maximum points while the minimum number of points could be ascribed to landscape design of settlements and buildings.

Discussions and results

Although Lithuania's territory is relatively not large, is it characterized by a variety of geographical complexes and landscapes. With regard to geographical aspects, landscapes of 22 types can be found here. From aesthetic point of view it was found that even 27 % of Lithuania's territory is picturesque and highly spectacular. There are plenty of objects in Lithuania (fig. 1), which have historic, cultural, natural potential and attraction for tourists. It allows developing cultural, educational, and medical tourism in regions where there are many of such objects whereas in non-fertile lands establishing rural tourism, water attractions and other forms of active tourism due to appropriate water and natural resources is possible.

In order to ensure sustainable development of the recreation system certain measures are predicted in the general plan of Lithuanian districts' municipalities: extension of recreational forest potential, development of passive rest zones near water reserves within the district, natural tourism development, adjustment of cultural heritage to society's recreational needs, development of cycling infrastructure and motor-tourism as well as the use of recreational potential within protected territories. Forests, parks, sea and other water reserves, geomorphologic structures, aesthetically valuable landscape complexes in Lithuania constitute around one third of the area. Visiting of areas suitable for tourism and recreation is assessed roughly by 60 mln days per year for an individual. Suburban recreational areas are also highly popular.

Fig. 1. Arrangement of Lithuania's recreational and tourism objects (available at: www.pamatyklietuvoje.lt) and extract from Kretinga district landscape, recreation and tourism drawing (available at: www.kretinga.lt/node/318)

These include parks, forest parks, rivers, lakes, other picturesque locations. Picturesque locations the natural components of which (water, forests, relief) are suitable for various recreation purposes constitute around 7.6 % of Lithuania's total area (Beržanskienė et al., 2015). They are composed of visual landscape areas that mostly reflect kinds of country's landscape, nature, culture and history. According to the statistical information, Vilnius Gediminas hill, Klaipėda Kopgalis, Kaunas Aleksotas Slope, Trakai square in front of the castle, Palanga bridge to the sea, a spot in dunes in Nida, Merkinė mound, Ladakalnis hill in Aukštaitija National Park, Šatrija Hill are among mostly visited objects. In 2014-2020 development plans of the analysed Kaunas, Trakai and Kretinga district municipalities, the analysis of the current situation is conducted. In addition, the existing development of recreation and tourism is analysed. Following this development plan, the sector of tourism services in the municipalities consists of catering, accommodation, active leisure services, museums and entertainment events. Having compared development plans of Kaunas, Trakai and Kretinga municipalities, certain differences were identified (table 2).

In the general and developmental plans of Kretinga district, regional tourism is assessed as the one that has big opportunities in comparison with other districts analysed. Analysing the plans of these municipalities, it was found that in Kretinga district development plan the most serious problem addressed is the accommodation sector since Kretinga district accommodates the smallest number of tourists both from abroad and locally (in comparison with other districts). From the table above we can see that comparing strengths of Kretinga district recreation and tourism with the neighbouring districts, it is characterized by high forest coverage, the number of cultural heritage objects and natural resources. The biggest weaknesses of the analysed districts are not developed cycling tracks and a small number of tourists. By increasing the attractiveness of tourism within the district, all recreational resources must be more prominent. Moreover, potential threats were identified, i.e. insufficient attention for dissemination of tourism information, insufficient involvement into activity of regional tourism, and not intense activity of tourism centres nearby. In the general plan of development in Kretinga district tourism is assessed as having huge potential in comparison to other districts analysed. Although one of the most popular resorts in Lithuania (Palanga) is situated nearby, which attracts a part of income to Kretinga district, the district itself is an attractive location regarding both natural and cultural-educational resources. In order to attract more tourists to the analysed municipalities, it is essential to intensify the dissemination of information about recreation objects, to establish the image of district tourism, reinforce accommodation and leisure services, especially the sector of active tourism.

Country's tourism resources are one of the most significant competition advantages seeking to attract tourists and increase the economic benefit of tourism. Natural and cultural resources of Lithuania's tourism as well as the structure of their attractiveness completely comply with the market of Northern and Central Europe tourism resources. Abundance and variety of Lithuania's natural and cultural tourism resources allows establishing active rest, cultural and educational as well as ethnic, rural and ecological tourism taking into consideration separate segments of the market. Value of Lithuania's landscape and market competitiveness for recreation and tourism is two-fold: providing physical value

such as comfort for recreation and psychological as well as emotional value like aesthetics. While analysing plans of Trakai municipality, it was also observed that in numerous places of Trakai municipality it is sought to maintain and preserve the view of the existing landscape as natural as possible.

Table 2

SWOT comparison of Kretinga, Kaunas and Trakai district municipalities

	SWOT statements	**Kretinga district**	**Kaunas district**	**Trakai district**
Strengths	Favourable geographical position	+	+	+
	Abundant cultural heritage objects	+	+	+
	Abundant natural recreational resources	+	-	-
	Slightly industry-affected environment	+	-	+
	Good air quality	+	-	+
	High forest coverage	+	-	-
Weaknesses	Not developed cycling tracks	+	+	+
	Low number of tourists	+	+	+
	Not developed touristic demand in protected territories	+	+	+
	Poorly used recreational potential	+	+	+
	Insufficient use of rural tourism	+	+	+
Opportunities	Rural development using district traditions	+	-	-
	Development of tourism services	+	-	-
	Increase in prominence of tourism resources	+	-	+
	Legalising the sector of accommodation	+	-	+
	Promoting possibilities of active leisure	+	+	+
	Increasing the staff of tourism information centre	+	-	+
Threats	Insufficient dissemination of tourism information	+	+	+
	Intense activity of tourism centres nearby	+	-	-
	Too low involvement into the regional tourism activity	+	+	+

However, numerous cultural, historic objects and settlements are not adjusted to touristic visits. Business infrastructure is not sufficiently developed (namely, catering and accommodation). The same could be said about physical infrastructure (access to touristic objects: road network, cycling tracks, information references, road signs). There is not enough support for tourism objects as well.

Due to huge amount of recreational resources, a part of recreation objects in the analysed locations has been forgotten or abandoned though they have favourable landscape for recreation and tourism. In order to assess attractiveness and sustainability of territories, the assessment of objects was conducted (table 3).

Having conducted the assessment, it was found that the objects which scored most points were located in Trakai municipality whereas the objects of Kretinga municipality scored the smallest number of points. Landscapes of the assessed objects are not very spectacular but they can all be adjusted to recreation. For instance, Jaurykla park in Kretinga district within the territory of the city can be fully arranged and adjusted to recreational needs of Kretinga town inhabitants while Kartena mound and Prystovai exposure can be included in natural routes of the recreational purpose as both these objects are within the territory of Salantai regional park.

Speaking about development possibilities of recreational territories in the analysed municipalities, different needs were noticed in each municipality. Having conducted the analysis of Kretinga district planning documents concerning recreation and tourism development and assessed recreational objects as well as having interviewed district inhabitants and specialists, it has been found that within the investigated district there is not enough adjustment of recreational infrastructure development and recreational objects to visiting as well as not enough information concerning recreational objects while further from Kretinga district centre there is a shortage of accommodation and catering institutions.

Table 3

Summarized data of the assessed objects

Assessment characteristics	**Kartena mound**	**Prystovai exposure**	**Jaurykla park**	**Trakų Vokė manour**	**Trakai island castle**	**Užutrakis manour**	**Varnikai cognitive trail**	**Saidė cognitive trail**	**Kaunas 5th Fort architectural reserve**	**Kaunas Reservoir Regional park**	**Pažaislis architectural ensemble**	**Dubrava marsh reserve**
General impression of the landscape	11	14	8	9	14	15	12	**17**	14	14	14	16
Relief expressiveness	19	27	14	9	21	19	17	**29**	15	13	15	16
Spatial diversity of flora	30	28	21	33	27	**38**	34	35	28	29	27	22
Variety of anthropogenic objects	21	11	13	22	**30**	25	12	12	17	28	29	27
Total:	81	80	56	73	92	**97**	75	93	74	84	85	81

Due to this reason foreign and local tourists' interest in the district is limited. There is the river Minija in Kretinga district, which is appropriate for water tourism. However, the potential of the river is not widely used. It is assumed that natural environment near the river Minija could be adjusted to extensive rest and recreation in nature. As well as this, development of campsites and temporary spots could be pursued. Moreover, establishment of rural tourism near Minija village could be encouraged, which should accommodate holidaymakers. In Minija ichtiological reserve development regarding natural tourism is possible. Infrastructure for visiting could be developed within the reserve and the park. Other natural objects could be adapted to visiting. In order to compete with other districts with regard to recreation and tourism, Kretinga district is supposed to pursue development within the district by directions of the towns, establish there tourism and information centres, to take care of the state of recreational objects and to prepare them for visiting. In addition, in order to become more prominent and disemminate information more intensely, the district should cooperate with neighbouring districts. Abundance of natural recreational resources, high forest coverage and low development of industry make favourable conditions for recreational tourism. Thus, it is reasonable to devote attention to improvement of recreational infrastructure and its developmnent. In order for Trakai district municipality to become the most competetive point with regard to tourism and recreation, development towards directions of district towns should be pursued. There tourism and information centres should be established. The districts should take care of the state of recreational objects and to prepare them for visiting. Moreover, seeking higher prominence of the district and more intense information disemmination, the district should cooperate with the neighbouring districts.

Abundance of natural recreational resources establishes especially favourable conditions for the development of recreational toruism. Thus, it is reasonable to pay attention to improvement of recreational infrastructure and its development in all analysed municipalities.

Conclusions and proposals

1. Having analysed general and development plans of Kretinga, Kaunas and Trakai municipalities, it was discovered that the main kind of recreational activity is educational recreation. However, in the analysed municipalities tourism infrastructure is not sufficiently developed and there is a shortage of companies providing accommodation.
2. Having assessed landscapes of recreational objects, it was noticed that in the objects assessed there is a big spatial diversity of flora and greenery prevails in the landscape. Landscapes are different but not very spectacular (the impression of object landscape does not exceed 50 points possible). They are also not fully adjusted to recreation and tourism.

3. In order to increase attractiveness of Kretinga, Kaunas and Trakai municipalities, the already established tourism and recreation spots should be maintained. Moreover, abandoned and forgotten territories should be established and prepared for visiting. Rural tourism spots, campsites and other accommodation places should be arranged.

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DOI: 10.22616/j.balticsurveying.2021.15.006

THE CONCEPTUAL FRAMEWORK FOR PROTECTION OF THE BIOLOGICAL DIVERSITY OF UKRAINE'S RURAL AREAS

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Abstract
Loss of the territory biological diversity is one of the most serious challenges for sustainable development of Ukraine. Solution of that problem is the essential constituent of the national ecological policy, which is focused on introduction of the ecosystem approach in all spheres of social and economic development, including protection of biological diversity. The goal of the article is to study some aspects of protection of the biological diversity of rural areas by means of ecosystem renaturalization by transforming degraded and marginal arable lands into forests, grassland and wetlands. The research proposes an organizational mechanism of increase and expansion of the territories with natural lands, which includes planning of land use, landscape and ecological zoning, territorial organization, evaluation of ecosystem benefits, land users' motivation. The researchers stress on the necessity to create ecological networks and agroforestry. Such structural organization of rural area supports a balanced combination of the "human-land-ecosystem" system due to protecting the main ecosystem functions, i.e., provision of regulating and habitat services. While determining the directions of use of the land plots with degraded and marginal arable lands, the obligatory condition is to justify the benefits from those ecosystem services. To regulate the environmental land relations, it is recommended to introduce conservation easement.
Key words: biological diversity, ecosystem services, degraded and marginal arable lands, rural area, organizational mechanism.

Introduction
Biological diversity or biodiversity is the variety of wildlife on the Earth. The larger biodiversity a territory has the more consistent and productive it is (Magurran A.E., Dornelas M., 2010). Moreover, biodiversity is a source of goods and services people obtain from the nature for their living (Business and the 2010 biodiversity …, 2005). In the scientific literature, goods of nature, which are actively or passively used to create well-being, are interpreted as ecosystem services (Fisher B., Turner R. K., Morling P., 2009). According to «The economics of ecosystems and biodiversity», those services are divided into 22 types and grouped into 4 categories, namely provisioning services, regulating services, habitat services, cultural & amenity services (TEEB – The Economics of Ecosystems …, 2010). Moreover, one ecosystem service can provide several benefits from its use (Boyd J., Banzhaf S., 2007). In general, the concept of ecosystem services denotes the interdependence between the human well-being and ecosystem stability, which is largely dependent on their biodiversity. In its turn, loss of biodiversity negatively influences the essential services, provided by the ecosystem, and it will cause great economic losses and healthcare cost (Millennium Ecosystem Assessment …, 2005).
The territory of Ukraine covers Polissia, Forest-Steppe, Steppe and mountainous landscape zones, which possess a powerful biodiversity (above 70 thousand kinds of animals and plants). However, development of industrial, agricultural, forest, and water economies, as well as urbanization has caused physical transformation of the natural landscapes. Almost 71% of the country's territory is used for agricultural purpose, including about 54% of the area is plowed. Forest vegetation covers only 16% of the territory. The conservation index is 6.6%. The ecosystem overuse is the reason of the extensive soil erosion, degradation of land cover, desertification and loss of biodiversity (The state of reflection …, 2017).
A particular focus is made on the natural resources management, which should secure their use, recovery and protection in the total compliance with the main principles of the biosphere organization. The approach to nature management, which is based on a consumer's attitude to natural resources, should be substituted by the approach, which expects a compromise between "non-interference" and "subjugation" of nature (Vernadskii V. I., 1965).
The noospheric focus of the society development is elaborated in the concept of the environment sustainable development, i.e. a general concept of economic development, which is to secure the optimal economic growth along with protection and improvement of the natural environment of human living (Hryniv L. S., 2016). Within the frame of that concept, sustainable land use should be considered as an integral process of recovery of a full complex of the "human-land-ecosystem" relations. Generation of such process should be implemented at the global, national and regional level, whereas its practical fulfilment should be secured at the local level through managerial decisions with consideration of each specific area peculiarities.
The goal of the article is to substantiate the expediency of use of the concept of ecosystem services while solving the problem of protection and recovery of biodiversity of the rural areas in Ukraine. The key task of the research is to determine the organizational mechanism of increase and expansion of the territories with natural lands.

Methodology of research and materials

Rural area is a geographical area outside cities, where agriculture is the principal kind of activity. Rural areas consist of different lands (arable land, hay fields, grassland, forests, shrubs, wetlands, water bodies, household buildings, roads, reclamation canals, etc.) and perform production, social and ecological functions (Rural area. National Geographic). The rural areas of Ukraine cover almost 90% of the land fund: arable land – 53.9%, hay fields and grassland – 13.0%, forests – 16.1%, shrubs – 0.7%, wetlands – 1.6%, water bodies – 4.0% (Land Fund of Ukraine).

According to the estimates by Ukrainian scientists, in Ukraine it is reasonable to reduce the area of arable lands by 6.5 million hectares for the purpose of renaturalization. It mainly includes degraded, marginal or erosion-dangerous land plots, which demonstrate low economic efficiency in crop production. It is recommended to transform 1.6 million ha of arable lands into meadowlands, and 0.7 million ha – into forests. It is recommended to use 0.2 million ha for revival, i.e., self-restoration of aboriginal ecosystems (mainly wetlands, alkali lands, rocky area) (Dobriak D. S., Kanash O. P. and others, 2009).

In the International Environmental Performance Index (EPI), Ukraine takes the 66th position (49.9 grades) by the Ecosystem Vitality category (Fig. 1).

Fig. 1. Rankings in the Ecosystem Vitality policy objective.
Source: The authors develop it based on (Wendling Z. A., Emerson J. W., et al., 2020).

The Ecosystem Vitality policy objective measures how well countries are preserving, protecting, and enhancing ecosystems and the services they provide. It comprises 60% of the total EPI score and is made up of seven issue categories: Biodiversity & Habitat, Ecosystem Services, Fisheries, Climate Change, Pollution Emissions, Agriculture, and Water Resources. Publicly available datasets were analysed in this study about Ecosystem Vitality (Wendling Z. A., Emerson J. W., et al., 2020). For 10 years, in Ukraine that index has reduced by 0.5 and confirms reduction of the ecosystem resilience and failure of the policy on conservation, protection and improvement of the ecosystems and the services they provide.

In the research, the abstract and logical method was used to make theoretical consolidation of the results, to shape conclusions and proposals; the method of sociological interviewing was used to collect information about the landowners' willingness to use lands for environmental purposes.

The interviewing was done among 150 people of the age from 30 to 65 years, who have privately owned land. Geographically, these lands are located in the western part of Ukraine (Lviv region, the hilly ridge of Roztocze). Some areas of arable land began to self-afforest (Fig. 2).

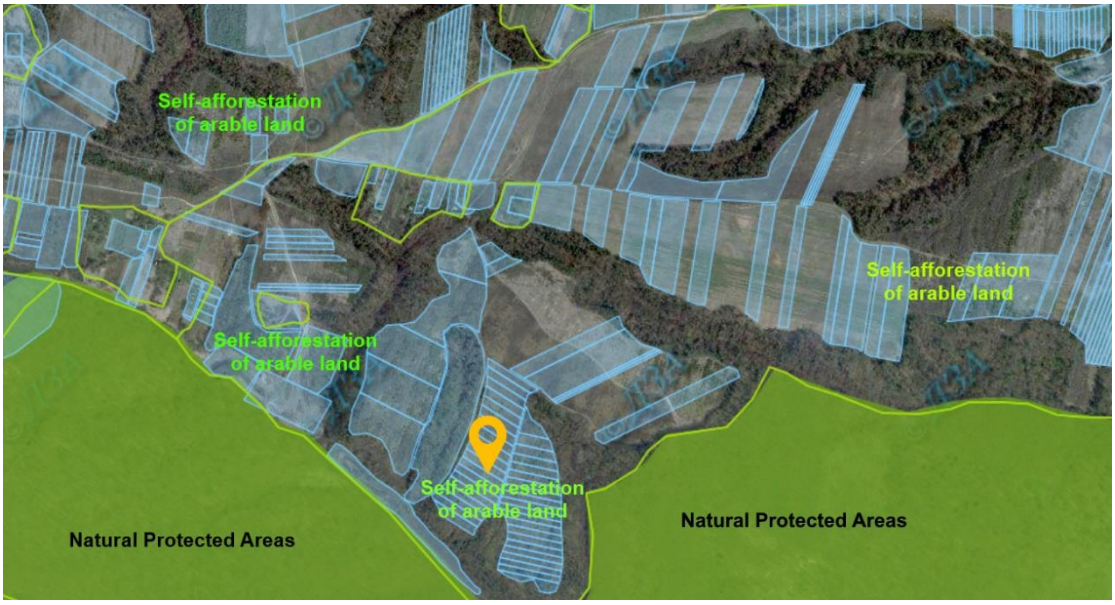

Fig. 2. Fragment of the cadastral map of Ukraine from study area.
Source: The authors develop it based on https://map.land.gov.ua/

To solve some tasks of the mentioned problem, the article applies the concept of ecosystem services in combination with such instruments as planning of land use, territorial organization, evaluation, motivation.

Discussions and results

The ecological policy of Ukraine until 2030 is focused on improvement of environmental conditions by applying the ecosystem approach to all directions of the social and economic development. The targets of that policy include reduction of losses of the biological and landscape diversity due to creation of an ecological network and protection of the unique natural landscapes; increase and expansion of the territory of the natural reserve fund; support for sustainable use and protection of lands, improvement of the conditions of damaged ecosystems (On the Basic Principles …, 2019). It justifies the necessity to consider the concept of ecosystem services while solving the problems of protection and revival of the biodiversity within rural areas.

Considering the variety of natural, social, economic, political and other conditions of rural territories development, there are no approved specific measures on improvement of the biodiversity of those territories. It is important to develop a complex of measures, focused on prevention or minimization of the processes of natural ecosystem degradation and recovery of the degraded area quality (Fig. 3).

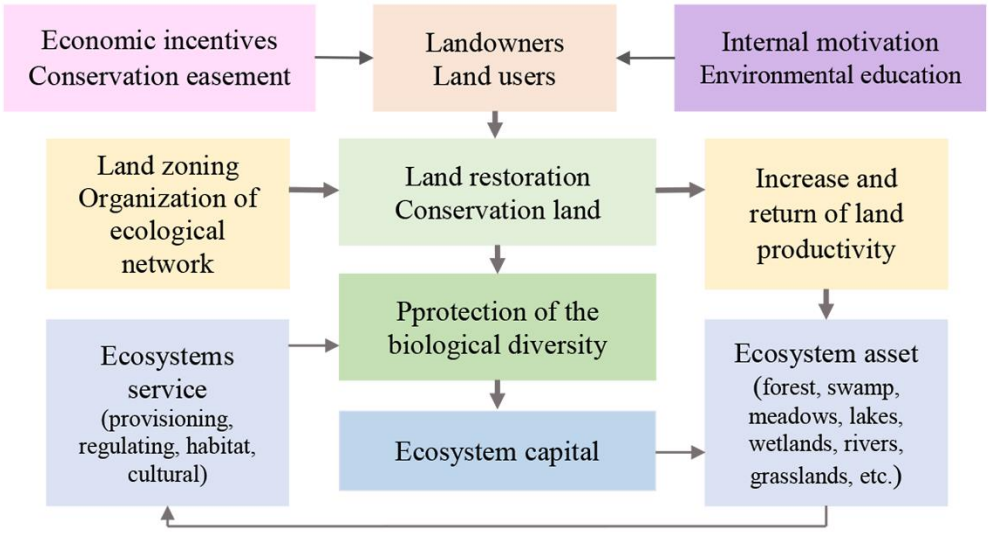

Fig. 3. The conceptual framework for biodiversity protection through the relationship between land conservation, restoration of land productivity and the formation of ecosystem capital.
Source: the authors develop it.

One of the methods to protect and recover the biodiversity in Ukraine is to expand the territory of natural lands using the degraded and marginal arable lands, which occupy the area of 6.5 million ha. The decision on a change of the land use structure by means of renaturalization should be made at the local level after a detailed analysis of the natural and ecological conditions. In July 2021, a new type of planning documentation "Complex plan of spatial development of the area of territorial communities" will come into force (On amendments to some legislative …, 2020). The authors of the article consider that the documents will solve the tasks, related with land conservation for environmental purposes and will serve as a basis for managerial decisions on the balanced land use.

While planning use of degraded and marginal arable lands it is recommended to make the landscape and ecological zoning of the territory (Stoiko N., Parsova V., 2017). It is used for grouping degraded and marginal arable lands by the types of use with consideration of their quality, estimates of the sensibility to anthropogenic burden, current use and determination of the target functions of the future development. It will provide the regime of land use and identify the regulations of land use within the corresponding zones and types. It is proposed to make the following distribution while zoning rural territories, particularly:

- agricultural zone with soil-protective, hayfield and grassland, garden, special type of land use;
- environment-stabilizing zone with the forest, water, reserve, recreation and mixed type of land use.

It is suggested that variability of the land use alternatives depends on the goals, which all participants of the planning process wish to achieve.

Deciding on the direction of use of the degraded and marginal arable lands, it is reasonable to consider the ecosystem benefits and services, provided by different ground ecosystems. That approach is basic for economic evaluation of the natural goods, including those, which do not have a direct market value, i.e. cannot be sold (protection of biodiversity, carbon sequestration, water purification, soil formation, etc.). In that context, it is important to secure protection of the biodiversity of lands, which is considered as a capability of the surface cover to support a sufficient photosynthesis activity and accumulation of the biomass, used by people (Dominati E., Patterson M., Mackay A., 2010; Science for Environment Policy …, 2015; Zero Net Land Degradation …, 2012). For that goal, forest lands, natural grasslands and wetlands are the best. Those territories should be afterwards organized in the form of the biocentric-network landscape-territorial structures (Hrodzynskyi M. D., 1995; van Strien M.J., Axhausen K.W. and others, 2018). Such step will support migration of kinds.

In practice, such arrangement of landscapes can be achieved by creating ecological networks. However, in Ukraine the process is aggravated by the heavy fragmentation of lands and agricultural development of the territory (Stoiko N., Cherechon O., 2019). Therefore, it is recommended to run agroforestry as an alternative in agricultural zone that is a system and technology of land use, which expects combination of crop production, animal breeding, gardening and forest husbandry within one farm, community or an area (Sarita Soraia de Alcântara Laudares, Luís Antônio Coimbra Borges and others, 2017). Such approach is a dynamic and ecologically argued method of natural resources management, which combines arrangement of lands with agricultural crops and tree vegetation. In practice, it secures diversification and support of production to increase the social, economic and ecological benefits for land users at all levels. Moreover, agroforestry is of significant value for small farms and rural citizens because it can improve their food supply, income and health.

To evaluate the service of the biodiversity protection, researcher's use the contingent valuation method, i.e. the value of ecosystem services is identified in the price, which respondents are ready to pay for the goods or to get reimbursement in case of the goods absence. The consumers' interviewing mainly determines it (Fig. 4).

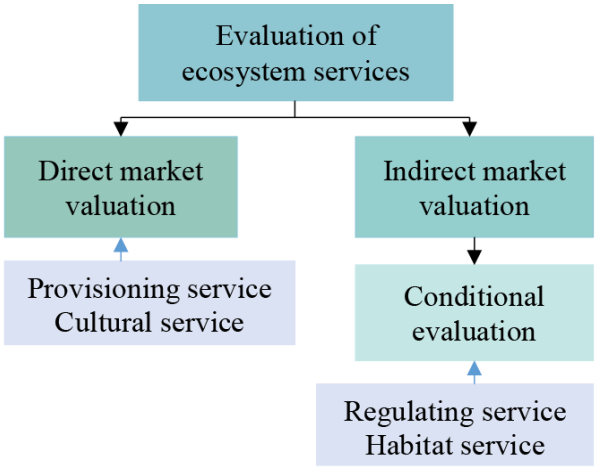

Fig. 4. Integrated valuation of ecosystem services considers.
Source: Adapted by us from (Soloviy I., 2016).

However, in Ukraine, land owners, even those having land plots of degraded and marginal arable lands, are not ready to submit their lands for environmental purposes or to pay for such natural goods as the biodiversity. Results

of the survey questionnaire demonstrate next: 32% respondents are against to stop the intensive land use, 34% – are ready to make temporary conservation, 10% – are ready to make permanent conservation in the form of forestation, 8% – are ready to sell their land shares to the state for environmental purposes, 16% – agree to make conservation upon condition of obtaining another land plot for agricultural production.

When social benefits, which appear in case of using degraded and marginal arable land for environmental purposes, cannot be related with the definite beneficiaries, it is proposed to complete a conservation easement to process payments for the ecosystem services production (Roddewig R., 2019).

Conservation easement – is a voluntary, legal agreement that permanently limits uses of the land (e.g., to plow, to apply mineral fertilizers, to make timber cutting, to conduct construction and others) in order to protect its natural values. The easement also expects protection of the land space for agricultural and forestry production; protection of the relatively natural environment for living the kinds of wild flora and fauna; protection of lands for environmental and recreational purposes. Such experience is new for Ukraine, but it is rather effective.

To improve motivation of landowners and land users to protect and recover natural ecosystems, including due to the degraded and marginal arable lands, it is required both to pay great attention to legal and economic instruments of management, and also actively develop the system of non-legal social responsibility, and particularly its constituent – ecological responsibility (Lokhorst A. M., Staats H, and others, 2011).

It is necessary for landowners and land users to master specific knowledge and practical skills on protection and recovery of the biodiversity, provided by the advisory, scientific and research, promotion and educational establishments. That advisory and educational function should be provided by the special institution, which is authorized to develop the internal motivation of land owners and land users to protect and recover productivity of natural ecosystems as a principal source of the regulating and habitat services. Therefore, the local population will be informed about the advantages and benefits they can get from forests, water bodies, grasslands, etc., as well as about the risks of the excessive anthropogenic impact on landscapes.

It is important to use the experience of the European Union in motivating and stimulating the support of biodiversity on private lands. European Union (EU) afforestation programmes applied to marginal agricultural land contribute significantly to strengthening the rural economy and provide multiple products and ecosystem services. However, it also contributes to the spread of invasive plants and trees, which is an environmentally hazardous phenomenon. Therefore, it is important to monitor the processes of ecosystem restoration. It is important to conduct special training and use effective methods to restore natural plants in order to preserve biodiversity (Lazaridou D. C., 2021).

Conclusions and proposals

1. In Ukraine, viability of natural ecosystems is ceased because of excessive anthropogenic burden on the environment. The potential reserve for expansion of the area with natural lands can be provided by degraded and marginal arable lands, which are recommended to be withdrawn of the intensive use for the forestation or grassing. It is important to use areas with self-seeding forests on agricultural lands to increase natural lands.
2. In spatial planning at the local level, it is suggested to make landscape-ecological zoning of rural territories, which involves determination of the land use types. It provides information for all interested parties about available reasonable directions of use of the degraded and marginal arable lands.
3. Substantiation of the transition of degraded or marginal arable lands into environmental territory needs determining the value of the potential ecosystem services, which can be obtained from the natural ecosystems (e.g. from forestation, grassing). For legalization of such transition of lands into the category of environmental territories, it is expedient to initiate the institute of the conservation easement of lands.
4. Concerning the landowners' motivation to change management of degraded or marginal arable lands basing on the ecosystem approach, it is recommended to define at the legislative level the procedure for the transfer of agricultural land for environmental purposes. Exempt landowners from paying land taxes, who save the natural capital in the form of biodiversity both for themselves and for future generations.

Acknowledgements

We are thankful to land owners of Lviv region for their participation in the interviewing and therefore their contribution to the research fulfilment.

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DOI: 10.22616/j.balticsurveying.2021.15.007

LAND USE AND ITS INFLUENCE ON ECOLOGICAL STABILITY OF THE AREA: CASE STUDY IN LITHUANIA

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Abstract

Several decades ago, land use and ecology in general were not a very relevant topic, but with the beginning of particularly intensive urbanization and agricultural expansion, scientists began to pay increasing attention to ecology and the improvement of related factors. The aim of the article is to analyse the land use of selected areas and its impact on the ecological condition of the area. 3 (Ignalina, Molėtai and Zarasai) from 15 districts (which are characterized by considerable forest cover and exceptional recreational characteristics) of Lithuania were selected as the object of research. The largest part of the area of these districts (44-57%) consists of agricultural areas, a slightly smaller area (32-42%) is occupied by forests and other natural areas. Artificial covers occupy from 8 to 11 percent of the total area of districts. Analysing the change of these land cover areas over a period of 12 years, a practically stable (4-6%) decrease of agricultural areas and growth of forests and other natural areas (3-5%) as well as artificial covers (1%) in all three municipalities are observed. Taking into account the prevailing land cover structure in the districts in 2018, the estimated degree of polarization of all districts/ecological stability indicator of the area exceeded 0.67, i.e., areas have been found to be ecologically stable. However, after assessing the ecological stability of the surveyed areas using a multi-criteria analysis method and introducing more criteria influencing the ecological condition of the area, not only the land cover structure, it was found that the ecological condition of Molėtai district is still the worst according to the ranking indicators, while that of Zarasai and Ignalina districts is very similar. Such a negative multi-criteria assessment of the ecological condition of Molėtai district was influenced by all criteria: lower area of protected and natural territories, forests in the district, higher population density, road length, area of artificial covers and emissions (carbon monoxides, nitrogen oxides, etc.) quantity. Meanwhile, when assessing the ecological condition of Ignalina district, 4 criteria were favourable, namely: relatively low population density, road length, and lower emissions of gases and liquids, carbon monoxide, and for Zarasai district 7 criteria: higher areas of protected territories, forests and other natural, agricultural areas as well as artificial cover areas and lower population density, emissions of nitrogen oxides, gaseous and liquid substances. The results of the study unambiguously revealed that the ecological stability of the territory is influenced not only by the land use structure, but also by other environmental elements related to the area, therefore for full sustainable development, it is necessary to responsibly assess all possible factors influencing the ecological condition of the area.

Key words: land use, ecological stability, multi-criteria analysis, CORINE

Introduction

Recently, land use in the world and its impact on the ecological stability of the area has become a very complex and relevant process. Comparing land use with the pre-industrial period, the impact of anthropogenic factors on the ecological stability of areas and climate change is significantly intensifying - forest areas are decreasing, arable land and urban areas are expanding, atmospheric gas composition is changing rapidly, the greenhouse effect and soil pollution are increasing as well. (Rockstrom, 2009; Verburg et al. 2011; Berndes, 2011; Food Climate Research..., 2018; Organization for Economic..., 2012, 2018 a, b; Bai et al, 2018). A similar situation, except for the decrease of forest areas, is happening in Lithuania. Often urbanized areas are expanded by reducing green spaces or areas of agrarian territories (Valčiukienė, 2012). Irrational planning of infrastructure and development of built-up areas also worsens the quality of the local environment (Organization for Economic..., 2018 a, b). Various negative changes in the country's landscape due to active agriculture, forestry development and rapid urbanization are becoming relevant to the country's governing bodies, which are interested in the ecological stability of the place, and attract the attention of scientists. Therefore, works aimed at describing changes in land use and determining their connections with the ecological condition of the area are becoming more and more relevant for this purpose (Veteikis, Piškinytė, 2019).

The aim of this article is to analyse the land use of selected areas and its impact on the ecological stability of the area. As can be seen from the above review of literature sources, the natural environment, where the forest cover of the area plays an important role, is important for the ecological stability of the entire area. The new Lithuanian Master Plan 2030 identifies 15 municipalities with their own forest cover and exceptional recreational characteristics (Lithuanian Master Plan ..., 2020). From these municipalities, 3 municipalities were randomly selected for the survey - Ignalina, Molėtai and Zarasai districts, located

in the eastern and north-eastern part of Lithuania. Detailed indicators of land cover structure and ecological stability in these municipalities are analysed in the further "Results" section of this article.

Methodology of research and materials

Research data and methods. The main data used in the study - the CORINE dataset was downloaded from the Lithuanian spatial information portal www.geoportal.lt. The information in this dataset on land cover in the survey areas in 2006 and 2018 was processed by ArcMap software. With the help of this software, *a comparative analysis of the data* was performed, during which the program filtered and compared detailed data on the land cover of the studied areas in 2006 and 2018 (artificial cover, agricultural areas, forests and other natural areas, wetlands and water bodies) and their areas occupied. After collecting and summarizing the land cover data, *the degrees of polarization* for 2006 and 2018, also known as *ecological stability coefficients*, were calculated for each district. There is no unified methodology for calculating this coefficient, there are several formulas. In this work, the formula was chosen, which was used by the staff of the Institute of Ecology of Vilnius University when preparing the report of the Lithuanian CORINE land cover project 2006 (Vaitkuvienė, Dagys, 2008) (1).

$$P_K = \sum_{i=1}^{n} \frac{d_1 S_1}{S} \quad (1)$$

where, P_K – the degree of polarization of the landscape;
d_i – naturalness index for the *i*-th cover type;
S_1 – area of the *i*-th land cover type of the area;
S – the area of the whole territory.

This formula makes it possible to calculate the ecological stability coefficient also for such areas that do not have a relatively large number of natural or artificial lands, as the result depends only on the value of the naturalness index (Table 1).

Table 1

Naturalness indices (Vaitkuvienė, Dagys, 2008)

CORINE land cover class	Naturalness index
Continuous construction	0.05
Discontinuous construction	0.15
Industrial or commercial objects	0.05
Road and rail network and associated land	0.05
Port areas	0.05
Airports	0.15
Mining sites	0.25
Landfills	0.15
Construction areas	0.05
Green urban areas	0.65
Sports and recreation areas	0.45
Non-irrigated arable land	0.35
Fruit and berry plantations	0.45
Pasture	0.45
Complex agricultural areas	0.55
Areas of arable land with inclusions of natural vegetation	0.65
Deciduous forest	0.95
Coniferous forest	0.95
Mixed forest	0.95
Natural meadows	0.95
Wilderness and heaths	0.75
Transitional forest stages and shrubs	0.85
Beach, dunes, sand dunes	0.95
Areas with poor vegetation cover	0.75
Fireplaces	0.75
Continental wetlands	0.95
Peatlands	0.85
Water flows	0.95
Water bodies	0.85
Coastal lagoons	0.95

The general values of the naturalness index were not singled out in the report of the Lithuanian CORINE land cover project 2006 prepared by the staff of the Institute of Ecology of Vilnius University, therefore the methodology developed by P. Aleknavičius (2008) was chosen to assess the general values of ecological stability coefficients (Table 2).

Table 2

Polarization coefficient/ecological stability value indices (Aleknavičius, 2008)

Coefficient values	Ecological condition of the area
≥ 0,67	Stable
0,51 – 0,66	Moderately stable
0,34 – 0,50	Not stable
≤ 0,33	Unstable

Since in this case the degree of polarization/ecological stability coefficient of the area only assesses the impact of the landscape on the ecological condition of the area, a multi-criteria analysis was performed to assess not only the impact of the landscape on ecological stability but also the impact of certain environmental elements on the ecological condition of the area identifying which of the study areas has the best ecological condition.

Table 3

Chosen criteria for multi-criteria analysis using PROMETHEE software (Source: compiled by the authors)

No	Criteria	Justification of the criteria
1	Protected areas (percentage of occupied area in the district)	Biodiversity conservation may be considered on the basis of protected areas such as nature reserves, sanctuaries and others. Therefore, the larger the area of these areas in the district, the more ecologically strong the district is likely
2	Forests and other natural areas (percentage of occupied area in the district)	Forests tend to be highly diverse and provide many ecosystem functions, including habitat supply, carbon sequestration, water regulation, and erosion prevention. Therefore, it is considered that the more forests there are in the area, the ecologically stronger the area
3	Agricultural area (percentage of occupied area in the district)	The biodiversity crisis is caused by factors such as agricultural development and logging, so growing agricultural land has a partial negative impact on the ecological condition of the district
4	Population density (population 1 sq. km)	Higher population concentrations are usually associated with higher energy consumption, which is one of the main drivers of greenhouse gases, especially carbon dioxide emissions
5	Artificial covers (percentage of occupied area in the district)	Urban development is another major driver of land cover change. The construction of buildings and other artificial surfaces contributes to the loss of sensitive ecosystems and the degradation of natural habitats
6	Road length (km)	Many factors contribute to greenhouse gas emissions. One of them is transport. For this reason, the developed road infrastructure has a negative impact on the local ecological status
7	Gaseous and liquid substances emitted into the ambient air from stationary pollution sources (tons)	The release of substances or mixtures into the environment has a negative impact on natural ecosystems and the ecological condition of the area in general
8	Carbon monoxide emitted into the ambient air from stationary sources (tons)	
9	Nitrogen oxides emitted into the ambient air from stationary pollution sources (tons)	

PROMETHEE software was chosen for *the multi-criteria analysis* by introducing certain environmental elements that may affect the ecological condition of the areas.
Taking into account the analysis of various scientific sources, 9 criteria were selected for multi-criteria analysis with the help of PROMETHEE software, which include not only certain elements of the landscape, but also assess certain elements of the environment (Table 3).
In assessing the criteria, data were taken from the Department of Statistics of the Republic of Lithuania (https://www.stat.gov.lt/), the CORINE dataset and from the Lithuanian spatial information portal www.geoportal.lt .
When performing a multi-criteria analysis and determining in which of the studied areas the ecological condition can be the best, assessing not only the landscape but also the environmental elements, the directions of the criteria become a very important element. The criteria directions are selected taking into account the usefulness or uselessness of the criterion for the selected multi-criteria analysis objective. The directions of the criteria and the main data matrix used for the multi-criteria analysis performed with the help of PROMETHEE software are presented in Table 4.

Table 4

Multi-criteria analysis data matrix and criteria directions (Source: compiled by the authors)

	Part of protected areas in the district	**Part of forests and other natural areas in the district**	**Part of agricultural areas in the district**	**Population density pop. / 1 sq. km in 2020**	**Part of the artificial cover in the district**	**Road length, km**	**Gaseous and liquid substances, tons**	**Carbon monoxide, tons**	**Nitrogen oxides, tons**
	max	**max**	**min**	**min**	**min**	**min**	**min**	**min**	**min**
Ignalina district	34	39	50	10,07	0,0171	1501	124,70	66,75	16,41
Molėtai district	30	32	57	12,59	0,0187	1738	202,36	113,67	19,30
Zarasai district	40	42	44	11,21	0,0149	1708	129,73	107,43	13,65

Two different calculation methodologies were applied in the multi-criteria analysis, as the obtained results depend not only on the available criteria, but also on the selected functions and values in the program. First, the *usual* priority function was applied to all criteria. Later, the *linear* priority function was chosen for the calculations. When using the usual priority function, all that matters is that the value of one indicator is higher than the other, but the size of the difference is irrelevant. In this case, the program gives a coefficient equal to 1 to the criteria favourable for solving the multi-criteria analysis problem. Meanwhile, the linear priority function includes the state of identity Q and the strict priority value P, and there is a linear relationship between these thresholds (Q and P), therefore, in this case, it is not the fact that one indicator is higher than another that is important, but the value of the change between indicators, so the program gives coefficient values from 0.1 to 1 depending on the selected Q and P values (Figure 1).

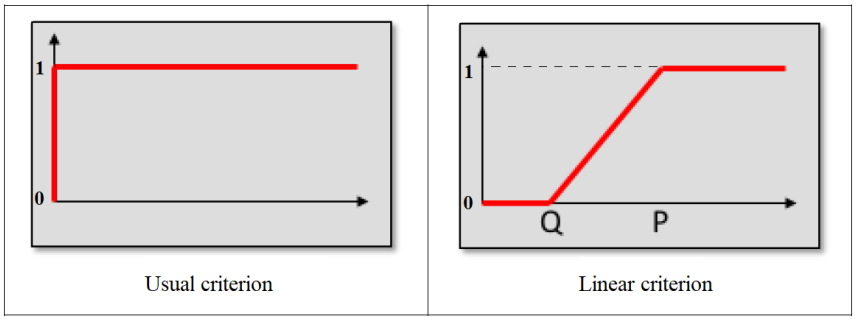


Fig. 1 Priority functions (Source: Mareschal, 2018)

The Q and P threshold values in the table below were used for the multi-criteria analysis (Table 5).

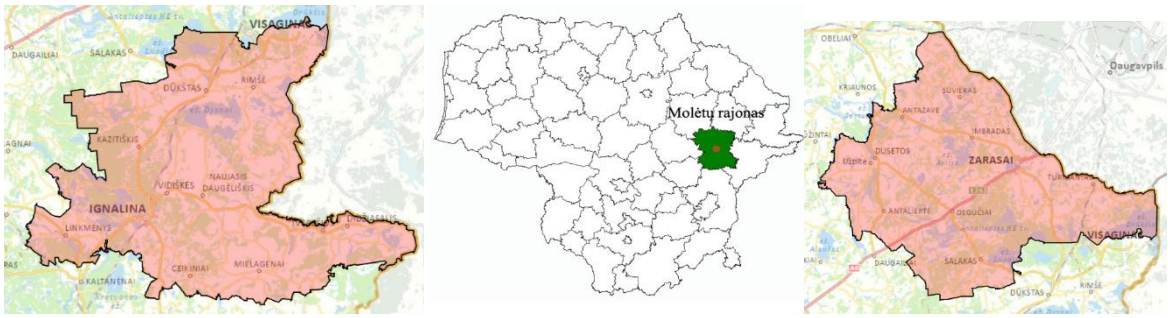
Table 5

Threshold values used in the multi-criteria analysis using the linear priority function
(Source: compiled by the authors)

Thres hold values	Pro-tected areas	Forests and other natural areas	Agricultural areas	Popula-tion density	Artificial covers	Road length	Gaseous and liquid substances	Carbon mono-xide	Nitro-gen oxides
Q	0.02	0.03	0.03	0.60	0.0009	91.33	33.12	17.89	1.33
P	0.09	0.10	0.12	2.28	0.0035	249.33	84.89	49.17	5.10

Threshold data was generated based on suggestions from PROMETHEE software.

Research objects. As already mentioned, three districts in the east and north-east of Lithuania all belonging to Utena county were selected for the study: Ignalina, Molėtai and Zarasai. Ignalina district municipality is a resort area, which is often described as the capital of the recreation area of Eastern Lithuania due to excellent conditions for rest and sports at all times of the year. The area of the district occupies one-fifth of the total area of the county, i.e. 1447 km² (Figure 2).



a) Ignalina district b) Molėtai district c) Zarasai district

Fig. 2 Districts selected for the study (Source: www.geoportal.lt)

Molėtai district municipality is also often referred to as one of the summer tourism capitals. The area of the district is slightly smaller than the Ignalina district - 19 percent of the county area, i.e., 1368 km^2. Zarasai district municipality is located in the north-eastern part of Lithuania and occupies about 18 percent of the territory of Utena county, i.e., 1334 km^2. Thus, all districts are characterized not only by their exceptional recreational characteristics, but also by their considerable forest cover (from 32 to 42% of the total area), which in ecological terms has a significant impact on the ecological stability of the area, but still occupies a significant part of other, less ecologically stable areas. A detailed analysis of the land cover areas of the studied districts and their trends are presented in the following part of the results.

Discussions and results

The analysis of Ignalina district land cover revealed that in 2006 more than half (54%) of Ignalina district areas consisted of agricultural ones, the largest area of which was occupied by non-irrigated arable land (32% of total agricultural area) and complex agricultural areas (30% of agricultural land areas) (Figure 3).

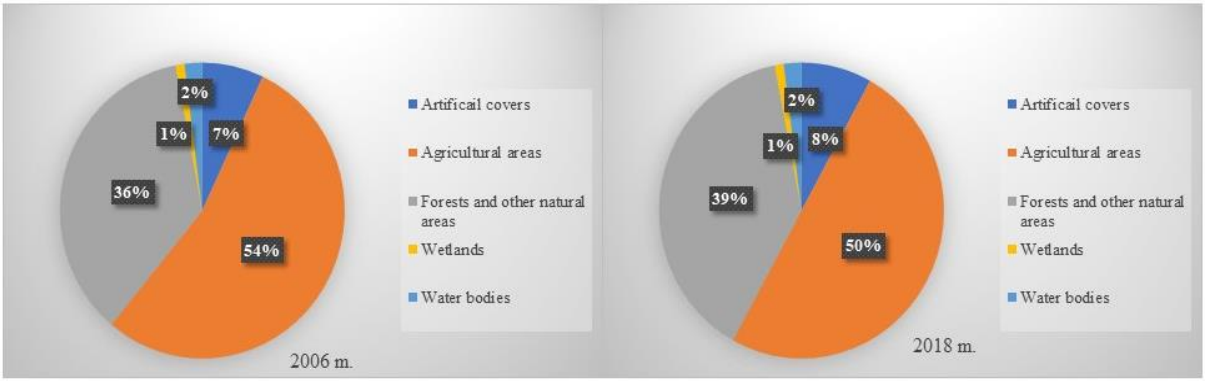


Fig. 3 Land cover in Ignalina district in 2006 and 2018
(Source: compiled by the authors based on the CORINE dataset)

In 2018, the structure of land cover in Ignalina district shows an obvious change in two cover areas: agricultural areas as well as forests and other natural areas. The decrease in agricultural areas (4858.69 ha, i.e., 4%) was mainly due to a quarter decrease in complex agricultural areas. Also, in 2018, compared to 2006, forests and other natural areas increased (4591.03 ha, i.e., 3%). The biggest impact on this change was the increase in the area of transitional forests and shrubs, which increased by as much as 89 percent in 12 years.
Meanwhile, in 2006, almost half (49%) of the area of Zarasai district consisted of agricultural areas, the largest area of which was occupied by arable land with natural vegetation inclusions (35% of agricultural area), complex agricultural areas (25% of agricultural area) and non-irrigated arable land (24% of agricultural area) (Figure 4).

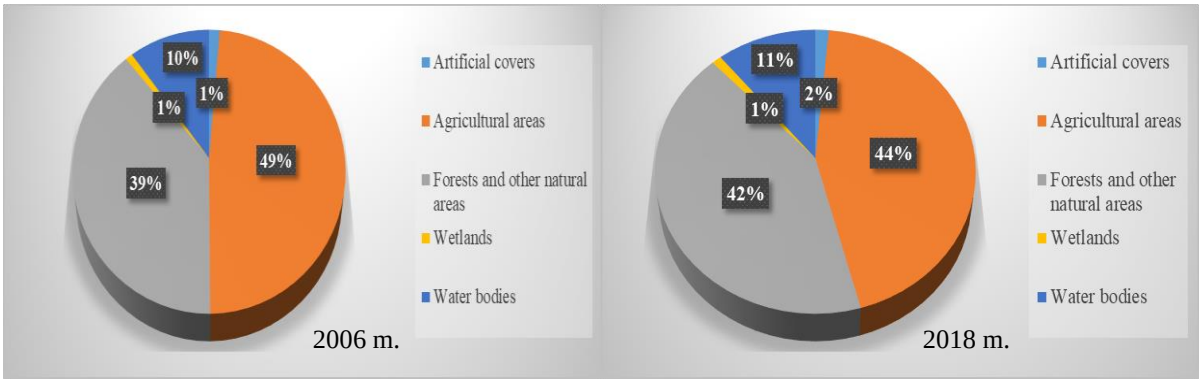


Fig. 4 Land cover in Zarasai district in 2006 and 2018
(Source: compiled by the authors based on the CORINE dataset)

In 2018, in the land cover structure of Zarasai district, it can be noticed that during 12 years the area of forests and other natural areas (4434.01 ha, i.e. 3%), water bodies (729.16 ha, i.e. 1%) and artificial cover (131.73 ha, i.e. 1%) increased. The change in the artificial cover was determined by the increased area of discontinuous construction. Forest area alone has grown by 3 percent (compared to 2006) due to increased transitional forest stage and shrub areas. It is also noticeable that the area of agriculture has decreased (5503.03 ha, i.e., 5%). The decrease in agricultural areas was mainly due to the halving of non-irrigated arable land.
Meanwhile, in 2006, almost two thirds (slightly less than 63%) of the territory of Molėtai district was occupied by agricultural areas (Figure 5). It consisted of non-irrigated arable land (29 percent), complex agricultural areas (33 percent) and arable land with natural vegetation inclusions (38 percent).

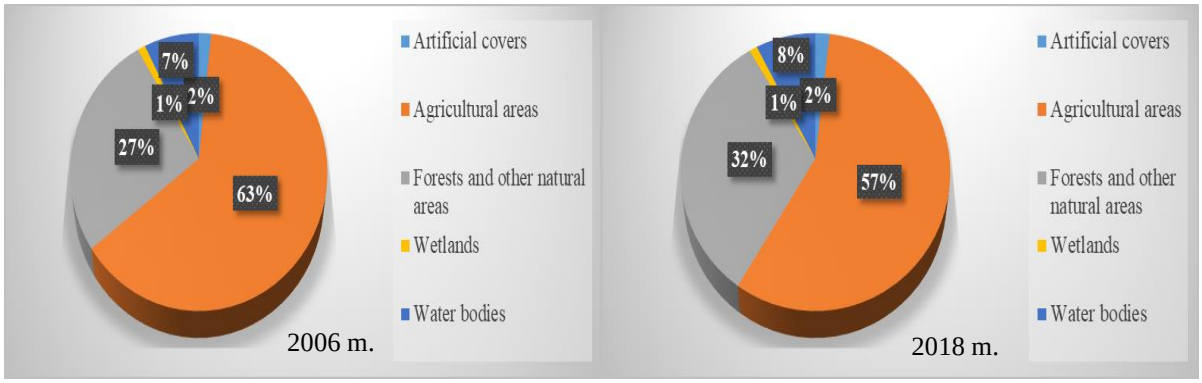


Fig. 5 Land cover in Molėtai district in 2006 and 2018
(Source: compiled by the authors based on the CORINE dataset)

Over 12 years, in the structure of the land cover of Molėtai district significantly decreased the agricultural area (7990.50 ha, i.e., 6%), increased the area of forests and other natural areas (7286.24 ha, i.e., 5%) a well as the area of artificial covers (341.81 ha, i.e. 1%). The decrease in agricultural areas was mainly due to a decrease of more than a third in non-irrigated arable land. Also, in 2018 compared to 2006 forests and other natural areas have grown strongly. This change was mainly due to the doubling of transitional forest stage and shrub areas.
Summarizing the structure of land covers in the districts and the tendencies of their change, it can be stated that the largest part of the area of all three districts (from 44% in Zarasai, 50% in Ignalina to 57% in Molėtai municipality) consists of other natural areas, respectively 42% – in Zarasai, 39% – in Ignalina and 32% in Molėtai municipality and artificial covers (8% each in Ignalina and Molėtai and 11% in Zarasai district municipality). Over a 12-year period (from 2006 to 2018) there is a practically steady (4-6%) decrease in agricultural areas and growth of forests and other natural areas (3-5%) as well as artificial covers (1%) in all three municipalities.
Using the analysed land cover data of the districts for 2006 and 2018, the calculated ecological stability coefficients for each of the analysed districts at the respective time period are presented in Figure 6.

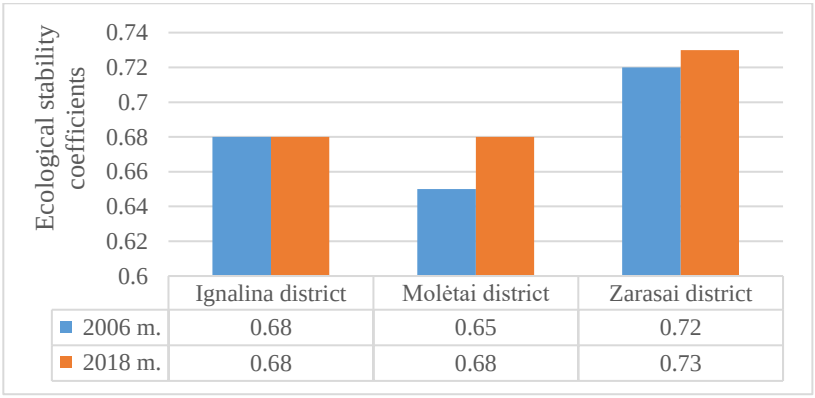


Fig. 6 Ecological stability coefficients of Ignalina, Molėtai and Zarasai districts

Based on the results presented on the obtained ecological stability indicators, it can be stated that when assessing the ecological stability of the area based on the structure of land cover throughout the analysed period, all areas are ecologically stable, i.e., all values of polarization coefficients exceed 0.67, except for the value of ecological stability coefficient of Molėtai district in 2006, which was 0.65. This value of the coefficient shows that the area in 2006 was moderately stable (Table 2), but in 2018 has already reached the ecologically stable area indicator (0.68). This was mainly due to a decrease (6%) in agricultural areas and a 5% increase in forests and other natural areas. Such trends in these areas have a positive effect on the ecological stability index of the area (Table 1).
However, as the analysis of scientific sources shows, the ecological stability of the area can be influenced by other criteria than the structure of the land cover (Table 3).

In a multi-criteria analysis using the PROMETHEE software ranking test, it was found that after choosing both the usual priority function and the linear priority function the order of the districts is the same, but the results obtained are not identical.

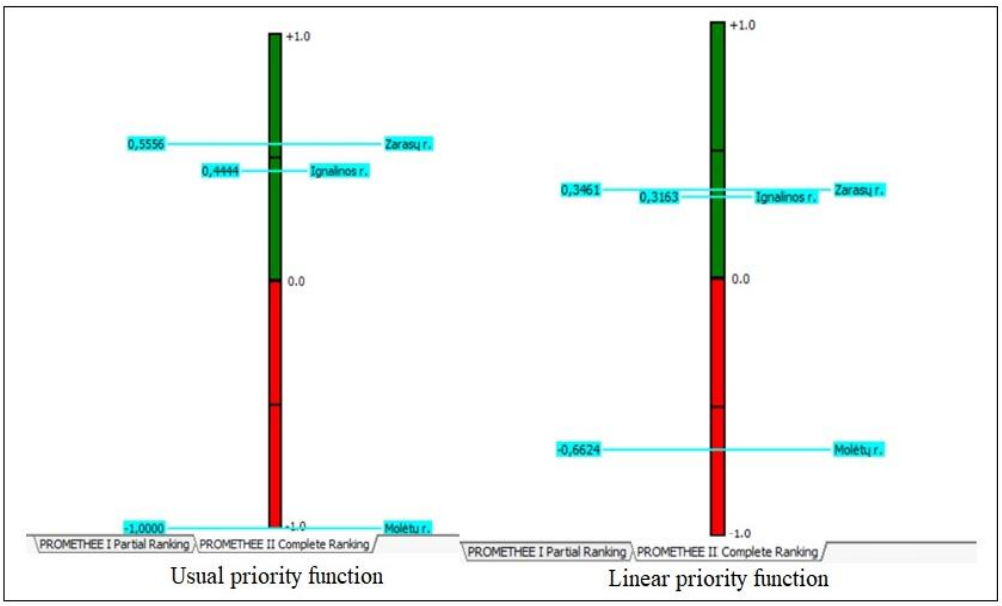


Fig. 7. PROMETHEE ranking test

After choosing the usual priority function, the best ecological condition is in Zarasai district, Ignalina district is in the second place, and Molėtai district is in the third place. Using the linear priority function and using the Q and P values recommended by the program, the ecological condition in both Zarasai and Ignalina districts is almost the same. The ranking coefficient of the ecological condition of Zarasai district is higher than the ranking coefficient of Ignalina district by only 0.03 points. As the difference is very small, it cannot be said that the ecological condition in Zarasai district is better due to possible errors in compiling and collecting statistics. Meanwhile, the analysis of both methods revealed that the ecological condition in Molėtai district is unambiguously the worst, despite the fact that using the linear priority function, the ecological condition ranking indicator of Molėtai district is slightly better (-0.66), and using the usual priority function (-1).

The most favourable indicators for the ecological condition of Ignalina district, i.e., those with the lowest values and a positive impact on the ecological stability of the area are presented in Figure 8, which shows the criteria for which the program assigns coefficients higher than 0.

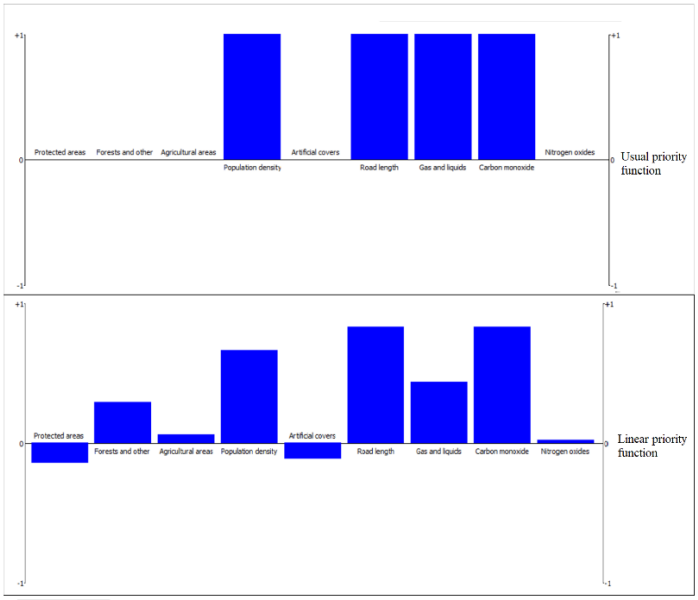


Fig. 8. Factors affecting the ecological condition of Ignalina district

As can be seen, the choice of the usual priority function revealed four criteria that are favourable to the ecological condition of the area: population density, road length, gaseous and liquid substances and carbon monoxide. Forests and other natural areas, agricultural areas and nitrogen oxides are also included in the favourable criteria using the linear priority function.
There are no favourable criteria for the ecological condition of Molėtai district using both calculation methods, but using the linear priority function the criteria ranking coefficients are slightly better than using the usual priority function, therefore the results obtained using different calculation methods are not the same (Figure 9).

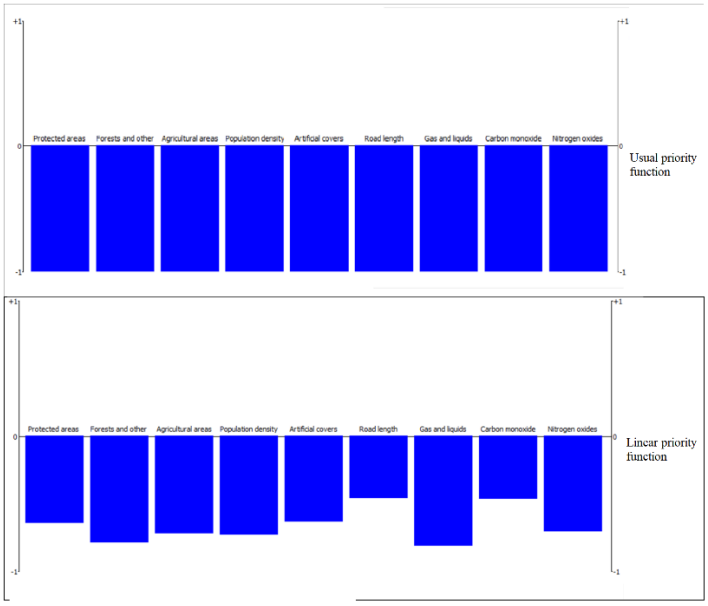


Fig. 9 Factors affecting the ecological condition of Molėtai district

Criteria favourable for the ecological condition of Zarasai district using different priority functions are presented in Figure 10.

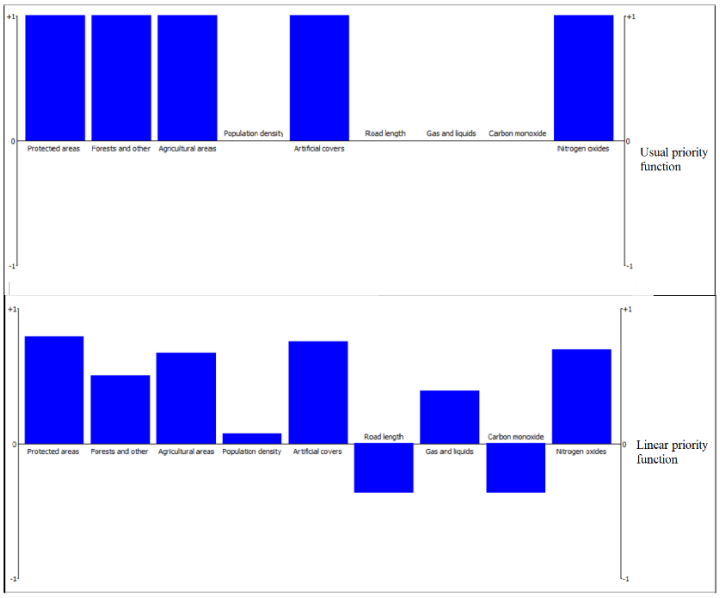


Fig. 10 Factors affecting the ecological condition of Zarasai district

The presented data show that when applying the usual priority function, 5 ecological conditions are favourable for the ecological condition of Zarasai district, namely: protected areas, forests and other natural areas, agricultural areas, artificial covers and nitrogen oxides, and linear priority function contributes population density, gas and liquids.

Thus, the assessment of the ecological stability of the districts using the multi-criteria method found that the ecological stability of the area is influenced not only by the land use, i.e. the structure of the cover of the area, but also other environmental elements related to the area, which, regardless of the positive ecological stability of it, may have a much opposite effect on the overall ecological stability of the area. As can be seen from the analysis, despite the sufficient area of forests and other natural areas as well as declining agricultural areas, which has a significant impact on the ecological stability of the area, other elements of the environment, such as emissions of gaseous and liquid substances, carbon monoxide and nitrogen oxides, or even the lowest possible population density and road network in the area, are equally important factors. Therefore, in order to achieve fully sustainable development of areas, in the planning and further management of them, which influences land use trends, it is necessary to responsibly assess as much as possible all possible factors influencing the ecological condition of the area.

Conclusions and proposals

1. In Ignalina, Molėtai and Zarasai districts, the largest part of the area (from 44 % in Zarasai, 50% in Ignalina to 57 % in Molėtai municipality) consists of agricultural areas, slightly smaller areas are occupied by forests and other natural areas, respectively 42 % - in Zarasai, 39 % - in Ignalina and 32 % in Molėtai municipality and artificial covers (8 % each in Ignalina and Molėtai and 11 % in Zarasai district municipality). Over a 12-year period, a practically even (4-6 %) decrease in agricultural areas and growth of forests and other natural areas (3-5 %) and artificial cover (1 %) were observed in all three surveyed municipalities.
2. Throughout the study period, depending on the structure of the land cover, the districts have positive ecological stability indicators, i.e., the values of the polarization coefficients exceed 0.67, except for the value of the ecological stability coefficient of Molėtai district in 2006, which was 0.65, i.e, the area was moderately ecologically stable. However, it is probable that due to the decrease in agriculture by the most -6 percent than in other districts and the increase in the area of forests and other natural areas by 5 percent, which have a positive impact on the ecological stability of the area, this area reached the ecologically stable area indicator in 2018 (0.68).
3. The multi-criteria analysis of the ecological stability of the districts showed that despite the positive ecological stability indicators when assessing the districts according to their land cover structure, the ecological condition of Molėtai district is still the worst according to the rating indicators (indicator values are -0.66 using linear priority function, using usual priority function - 1), while the ecological condition of Zarasai and Ignalina districts is very similar. Such a negative multi-criteria assessment of the ecological condition of Molėtai district was influenced by all criteria: lower area of protected territories, forests and natural areas in the district, higher population density, road length, area of artificial covers and emissions (carbon monoxides, nitrogen oxides, etc.) quantity. Meanwhile, when assessing the ecological condition of Ignalina district, 4 criteria were favourable, namely: relatively low population density, road length, and lower emissions of gases and liquids, carbon monoxide, and for Zarasai district 7 criteria: higher protected areas, forests and other natural, agricultural areas and artificial cover areas as well as lower population density and emissions of nitrogen oxides, gaseous and liquid substances.
4. The results of the study unequivocally revealed that the ecological stability of the area is influenced not only by land use, i.e., the structure of the area cover, but also other environmental elements related to the area, such as emissions of gaseous and liquid substances, carbon monoxide and nitrogen oxides, or even the lowest possible population density and road network in the area. Therefore, in order to achieve fully sustainable development of areas through territorial planning and further management, which also influences land use trends, it is necessary to responsibly assess all possible factors influencing the ecological condition of the area.

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DOI: 10.22616/j.balticsurveying.2021.15.008

RESIDENTIAL REAL ESTATE PRICE MODELLING THROUGH THE METHOD OF THE GEOGRAPHICALLY WEIGHTED REGRESSION: GOMEL CITY CASE STUDY

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Abstract
One of the most challenging tasks in modelling of house pricing is to take into account the location factors. Geographically Weighted Regression (GWR) as a local regression model is an extremely effective instrument for spatial data analysis. The aim of the study is to model the relationships between a residential real estate price (per sq.m) and both building and location characteristics for Gomel using GWR. The data of the Belarus' National Cadastral Agency on real estate transactions (apartments) in Gomel in 2019 are used as initial. The global Moran I index has been used to estimate a spatial autocorrelation of the dependent variable (price per square meter of residential real estate). Several factors having the impact on the apartment sale prices have been determined. Independent variables having been used in analysis can be divided into building characteristics and spatial characteristics. The building characteristics section includes the number of rooms within the property, property area (square meters), building age, number of floors in the building, floor of the property. The spatial characteristics group contains proximity to city center, recreation areas, supermarkets, bus stops, healthcare and educational facilities. A regression model of housing price in Gomel has been developed. Mapping variable regression coefficients allows exploring spatial features of the impact of the different explanatory variables on the property price. Geographically weighted regression modelling has revealed the pricing peculiarities inherent for certain areas of the city.
Key words: Geographically Weighted Regression, spatial autocorrelation, spatial models, residential real estate market, price modelling.

Introduction

A number of qualitative and quantitative methods are used to assess the impact of property characteristics on the prices and value of real estate. Qualitative methods are more commonly used in weakly developed real estate markets. Quantitative methods generate more well-founded results, but their application presupposes the fulfillment of many formal and statistical requirements. Many studies have used a hedonic modeling approach (essentially a traditional multiple regression model formulation) to analyse the property market (Chau, Chin, 2003). Regression analysis is a statistical technique for determining one or several independent variables' impact on a dependent variable. The classical regression models used in real estate market analyses cannot take into account spatial autocorrelations of analysed data and spatial heterogenity of price formation process (Cellmer, 2012). Application of Geographically Weighted Regression (GWR) to real estate market analysis allows account spatial heterogeneity (non – stationarity) of analyzed phenomenon as is spatial distribution of prices (Cellmer et al., 2020). GWR is an extension of ordinary least squares regression that modells relationships as they vary across space by estimating regression coefficients locally at spatially referenced data points. Geographically weighted regression is being increasingly used in identifying price determinants (Dziauddin et.al., 2015; Tomal, 2020), pricing modeling (Cao et.al., 2019; Wang et.al., 2020) and real estate market segmentations (Manganelli et.al., 2014).

The object of investigation – residential real estate market of Gomel.

Gomel is the second largest city in Belarus after Minsk and is characterized by fairly high housing prices. Compared to Minsk (the capital of Belarus), the real estate market is less active, more predictable, there are no sharp price rises.

The aim of investigation – to model the relationships between a residential real estate price (per sq.m) and both building and location characteristics for Gomel during 2019 using GWR.

Methodology of research and materials

In the present study we have used data from the Belarus' National Cadastral Agency. The real estate transactions (apartments) in Gomel in 2019 have been analyzed. The total number was 1,046 purchase and sale transactions. The transaction database has been formed on the basis of information from the land plot price register of the state land cadaster. Recorded prices are the sale prices of completed transactions. Transaction data includes information about such characteristics of property as its address, construction year, wall material (bricks, large prefabricated panels, monolithic reinforced concrete, lightweight concrete blocks), building number of floors, property floor, property number of rooms, property area (square meters). The sample of purchase and sale transactions is limited to 2019 year. In 2019, there were no significant price changes in the residential real estate market. The modelling

of residential real estate pricing through the method of GWR was carried out in several steps: identifying and modelling the spatial factors influence on a price, statistical data analysis, assessment of spatial autocorrelation, conducting Geographically Weighted Regression.
Both internal and external factors affecting the residential real estate price were preliminarily identified and prepared. Internal factor group includes such characteristics as the property area, building age, number of floors in the building, floor of the property, wall material, number of property rooms. The external or spatial factor group contains proximity to the city center, recreation areas, supermarkets, bus stops, healthcare and educational facilities. The spatial factors models were constructed in the environment of ArcGIS 10.8 with using Euclidean distance tool. Units of measurement are meters. The data of the State Land Cadastre and OpenStreetMap project were used as a vector spatial basis.
Statistical data analysis includes the variable distribution assessment with the help of histograms and fitting criterions (the Kolmogorov-Smirnov test, the Shapiro-Wilk test), calculating descriptive statistics, nonparametric correlation analysis.
Spatial Autocorrelation Analysis was implemented with global and local Moran's I statistics (Anselin, 1995).
The Geographically Weighted Regression analysis was used to model the relationship between an apartment price and some building, property and location characteristics. GWR is a non-stationary technique that models spatially varying relationships. A GWR model can be written as (Fotheringham et al., 1998, 2002):

$$y_i = \beta_0(u_i, v_i) + \sum_k \beta_k(u_i, v_i)x_{ik} + \varepsilon_i \quad (1)$$

where y_i is the value of the outcome variable at the coordinate location i where (u_i,v_i) denotes the coordinates of i, β_0 and β_j represents the local estimated intercept and effect of variable j for location i, respectively.
The Geographically Weighted Regression model was implemented by the ArcGIS Desktop Software (Version: 10.8; Type: Advanced).

Discussion and results
Analysis of purchase and sale transactions in Gomel secondary housing market has showed that apartments prices (measured in USD per square meters) were variable, ranging from 250 to 750 USD, with an average of 544 USD. A Histogram of housing prices with a normal distribution curve is shown in Figure 1. According to the histogram and Goodness-of-Fit criteria, the data are consistent with the normal distribution. Therefore, the raw data were used for geographical weighted regression.

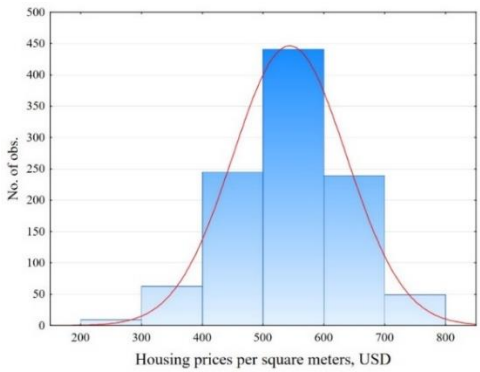


Fig. 1. Histogram of apartment prices (per square meters)

Considering the spatial distribution of apartment unit prices (measured in USD per square meters), two types of spatial association are tested: global spatial autocorrelation and local spatial association. Global spatial autocorrelation has been estimated by Moran's I statistic. It appears that apartment unit prices are positively spatially autocorrelated at p = 0.001 significance level which allows to use the geographically weighted regression for price modelling. The identification of local spatial association has been carried out by the means of local Moran's I. The results of the global Moran's I and LISA analysis are illustrated in Figure 2.
A large high–high spatial cluster is observed in the northwestern part of Gomel, mainly within Central administrative district of the city. A relatively small high-high spatial cluster is located within the Shvedskaya Gorka microdistrict in the southern part of the city while some low–low spatial clusters have been found in the middle and eastern areas of Gomel.

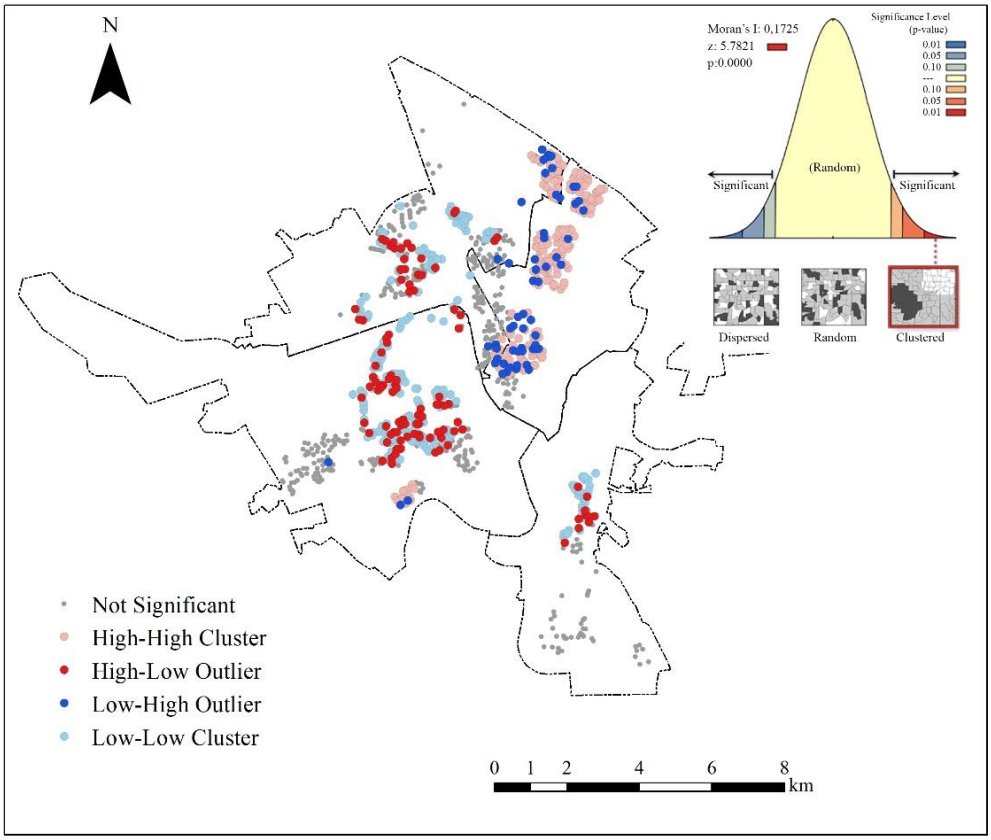


Fig. 2. Spatial clusters and spatial outliers map of apartment unit prices in Gomel

The relationships between apartment prices per m² (sqm) and building and location characteristics have been investigated with Spearman correlation coefficients. The results are summarized in Table 1.
The correlations between price per m² and eight indicators are significant: property area, building age, number of floors in the building, floor of the property, wall material and proximity to recreation areas, healthcare and educational facilities (Table 1). The characteristics having the greatest impact on the price are: building age and number of floors in the building.

Table 1

Spearman correlation coefficients between apartment prices per m²
and building and location characteristics

Variables	r
Property area (square meters)	0.064
Number of rooms	-0.039
Building age	-0.327
Number of floors in the building	0.285
Floor of the property	0.175
Wall material	0.120
Proximity to the city center	-0.030
Proximity to recreation areas	-0.141
Proximity to supermarkets	0.044
Proximity to healthcare facilities	0.182
Proximity to educational facilities	0.078
Proximity to bus stops	-0.005

Significant coefficients at the significance level 0.05 are determined in bold

Prior to establishing the final list, the independent variables were subjected to preliminary exploratory regression. There are evaluated all possible combinations of explanatory variables looking for the Ordinary Least Squares (OLS) models passing all necessary diagnostics. The summary of variable significance is presented in table 2.

Table 2

Independent variable significance (exploratory regression analysis)

Variables	Significance, %
Building age	100
Proximity to healthcare facilities	100
Proximity to recreation areas	100
Proximity to the city center	92
Proximity to supermarkets	86
Number of floors in the building	88
Wall material	82
Floor of the property	65
Number of rooms	41
Proximity to educational facilities	31
Property area (square meters)	30
Proximity to bus stops	7

To model the relationships between apartment price (per sq.m) and some building and location characteristics the Geographically Weighted Regression technique has been implemented. The explanatory variables in the model were property area (square meters), number of floors in the building, floor of the property, wall material, proximity to the city center, recreation areas, supermarkets, healthcare facilities. The inclusion of explanatory variables in the GWR model was carried out based on correlations between independent and dependent variables, the significance of the independent variables estimated by exploratory regression analysis and the absence of multicollinearity among independent variables. The Gaussian kernel is used for GWR model and the kernel type is fixed. The bandwidth is 950 meters. Table 3 presents the basic diagnostic statistics of the GWR model.

Table 3

Basic diagnostic statistics of the GWR model

Diagnostic content	Value
Number of observations	1046
Bandwidth	945
Residual squares	10099.18
Sigma	111.23
AICc	10.06
R^2	0.77
Adjusted R^2	0.74

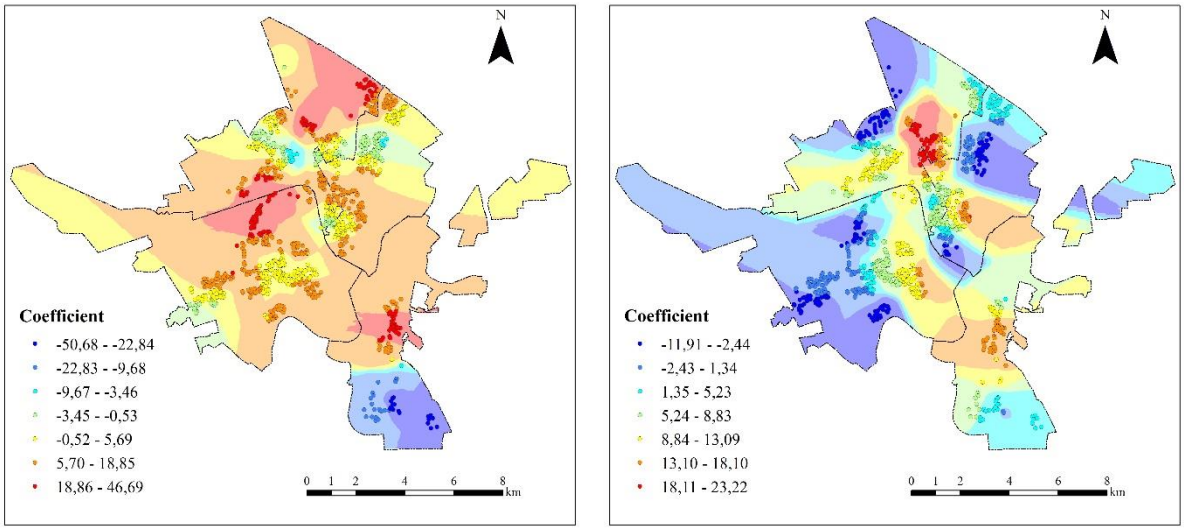
Geographically weighted regression lets the regression parameters to differ locally by disseminating location-wise parameter estimates for all independent variables (Fotheringham et al., 2002). Table 4 shows the results of the GWR model parameter estimation. A local determination coefficient R^2 varies from 0.05 to 0.97.

Table 4

Results of the GWR model parameter estimation

Variable	Min	Mean	Max
Intersept	-982.209	525.059	1187.275
Property area (square meters)	-2.649	-0.684	1.487
Building age	-7.883	-1.001	4.502
Number of floors in the building	-11.905	5.460	23.224
Floor of the property	-11.963	0.568	11.859
Wall material	-50.676	7.055	46.687
Proximity to the city center	-0.094	0.001	0.198
Proximity to recreation areas	-0.151	-0.014	0.329
Proximity to supermarkets	-0.491	0.009	0.184
Proximity to healthcare facilities	-0.134	0.010	0.242

The GWR allows visualizing and exploring the spatial variability of explanatory variables in the model. The model parameter estimates of explanatory variables may vary significantly over a geographical area. Spatial distribution of the coefficients estimates for variables most affecting the apartment`s price are presented at Figure 3. The greatest variability was observed for the variable “Wall material”. The direction and degree of the parameter influence varies throughout the city areas.



a **b**

Figure 3. The spatial distribution of the GWR coefficients:
(**a**) wall material; (**b**) number of floors in the building

The Moran's I-statistic has been calculated to measure the (global) spatial autocorrelation for GWR residuals. Small value of Moran's I (-0.0306) indicates a residuals spatial random distribution, which in turn suggests a good GWR fit (Figure 4).

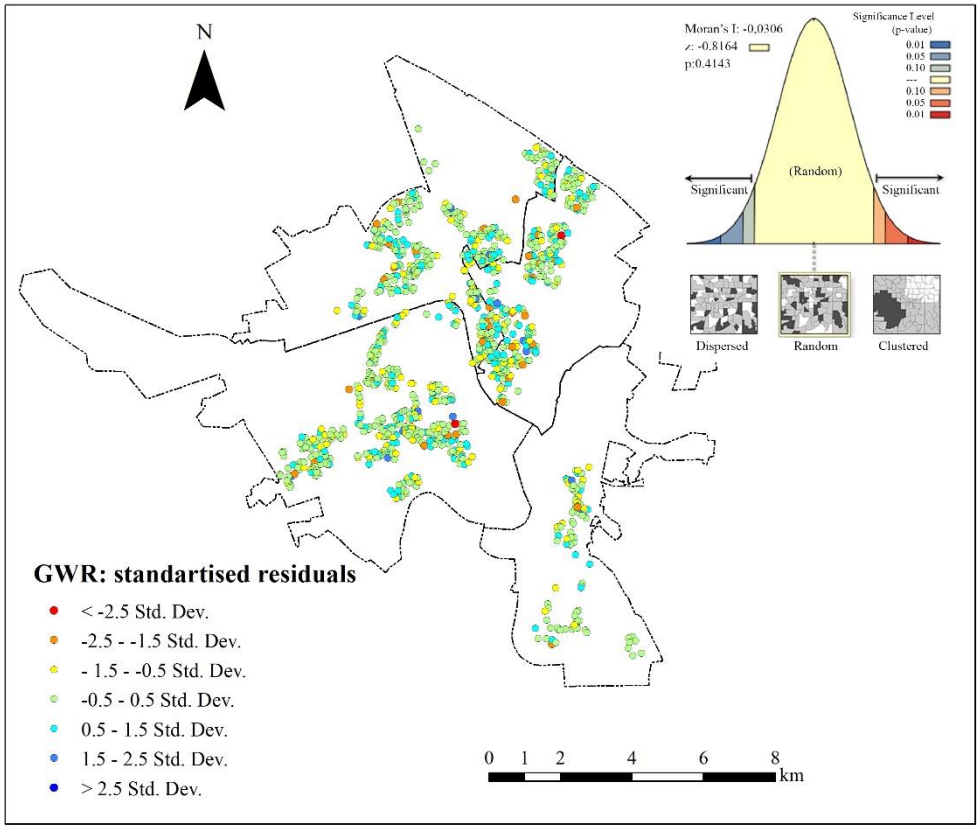


Fig. 4. Standard residual of Geographically Weighted Regression for apartment unit prices in Gomel

Conclusions and proposals

In this study, we investigated the relationships between residential real estate price (per sq.m) and both building and location characteristics for Gomel during 2019 using GWR. Geographically Weighted Regression is local regression technique which takes into account spatial heterogeneity. Several factors having the impact on the apartment sale prices have been determined. The final GWR model includes explanatory variables based on two categories: building and apartment characteristics (property area (square meters), building age, number of floors

in the building, floor of the property, wall material) and location characteristics (proximity to city center, recreation areas, supermarkets, healthcare facilities). A regression model of housing price in Gomel has been developed. The main output from GWR is a set of localised parameter estimates and associated diagnostics. The GWR adjusted R^2 has been 0.74 (R^2 is 0.77). AICc has given a value of 10.06. Mapping the GWR model coefficients allows exploring the spatial features of relationships between residential real estate price (per sq.m) and explanatory variables. The spatial autocorrelation of GWR residuals for our model have resulted in a Moran's I value of −0.03 ($p = 0.414$), indicating a residuals spatial random distribution, which in turn suggests a good GWR fit.

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