LATVIA UNIVERSITY OF LIFE SCIENCES AND TECHNOLOGIES
UNIVERSITY OF WARMIA AND MAZURY IN OLSZTYN (Poland)
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FOREWORD

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The journal includes original articles on land administration, land management, real property cadastre, land use, rural development, geodesy and cartography, remote sensing, geoinformatics, other related fields, as well as education in land management and geodesy throughout the Baltic countries, Western and Eastern Europe and elsewhere. The journal is the first one in the Baltic countries dealing with the mentioned issues. Journal disseminates the latest scientific findings, theoretical and experimental research and is extremely useful for young scientists.

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CONTENT

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INVESTIGATION OF THE ACCURACY OF SPATIAL DATA OF THE GRPK BUILDING LAYER IN THE TERRITORY OF LITHUANIA

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Abstract
Spatial data is constantly evolving, and the accuracy of spatial data is constantly changing. The latest GRPK and orthophotographic map were used in the study. Accuracy is also affected by technological advances, which are driven by improvements in working methods, which include the development of work tools and the development of data sets that contain structured data. The data contained in the data sets are determined by a variety of methods, such as field measurements (GPNS receiver or tacheometer) and analysis of digital photographic images, which are determined using aircraft or satellite systems. The determined data is processed with the help of specialized software, which is selected depending on its functionality and capabilities, and with the help of which the determined data is processed as accurately as possible. Accurate spatial data in densely populated areas makes it easier to carry out planning and design work correctly. The study is performed to determine the accuracy of the coordinates of the selected structures using remote methods. The more similar studies are conducted, the more confident the GRPK data generated remotely will be of the required accuracy, reliability, and applicability to planning, forecasting, and other important tasks.
The article compares geodetic measurements and GRPK data and geodetic measurements and ORT10LT data, identifies coordinate differences, the size of the discrepancy and its average, and calculates the root mean square error.
The object of the research is spatial and cartographic data of different buildings.
The aim of the research is to determine and evaluate the accuracy of the coordinates obtained using remote sensing methods.
Key words: GRPK, ORT10LT, geodetic surveys, spatial data set, accuracy study

Introduction

The use and analysis of GRPK and ORT10LT data is relevant as it is constantly updated. Georeferenced data, as well as their updating or submission, are important because they help to plan and design and analyze processes related to land cover change (Gudritiene, 2016; Salkauskiene et al., 2017). Spatial data are analyzed by many scientists in various fields: Sustainable forest management and ventilation (Tiskutė-Memgaudiene et al., 2020), mapping of forest infrastructure objects Bikuviene et al., 2020), monitoring of land use changes (Jukneliene et al., 2021), mapping of damaged areas (Korol et al., 2021), landscape (Tykhenko et al., 2020) and others.
Accurate spatial data in densely populated areas makes it easier to carry out planning and design work correctly. The study is performed to determine the possibilities of the accuracy of static coordinates using remote methods. The more similar studies are conducted, the more confident the GRPK data generated remotely will be of the required accuracy, reliability, and applicability to planning, forecasting, and other important tasks.
The most accurate data from geodetic measurements are used for comparison in the coordinate accuracy study and will serve as a basis for analyzing the data found in orthophotographic maps. The data collected by remote methods will be compared with the data obtained from geodetic measurements in order to find out how accurately the visually determined coordinates of land cover objects - structures - can be determined remotely. The building layer data provided by GRPK are usually determined by camera interpretation of orthophotographic maps, which are collected and stored in the ORT10LT data set. GRPK data must be based on the photographic basis of the most recent orthophoto map. The coordinates provided by the GRPK and their accuracy depend directly on the quality, accuracy, resolution, interpretation and data entry of the orthophotographic map. ORT10LT and GRPK data are publicly available and used by professionals in many fields. This study will investigate the accuracy of the coordinates of the turning points of the buildings provided by GRPK, as well as find out the reasons for the discrepancy of the coordinates with the geodetic coordinates. The map will be interpreted in a camera way to determine the reasons. Thus, the study of the accuracy of remotely determining coordinates is relevant to assess whether such publicly available public data is of sufficient quality and meets the accuracy requirements.

The aim of the research is to determine the accuracy of the spatial data of the GRPK building layer in the Kaunas and Alytus district municipalities.
Objectives of the article are as follows:
1) To determine the accuracy of spatial data (building turning points, X and Y coordinates) provided by GRPK for one- and two-storey buildings and buildings that are not covered and are covered by surface objects.
2) After analyzing the obtained data, discuss the reasons that may have led to discrepancies in the obtained data.
3) Perform ORT10LT interpretation and compare the obtained data with GRPK spatial data.
Electronic tacheometers or GPS receivers are used for measurements in unoccupied areas, and there are no significant differences in measurement accuracy between these devices. However, it has been found that in urban areas, more accurate data are obtained by measuring electronic tacheometers (Balevicius et al., 2013). In order to evaluate the real (external) accuracy of the created orthophotographic map, it is necessary to determine the coordinates of the points in the orthophotographic photo by photogrammetric measurements and compare the results with the geodetic measurements in the area. To calculate the accuracy, the values of standard deviation and standard deviation are calculated (Ruzgiene et al., 2012; Ruzgiene, 2015).
2007 In Lithuania, the network of permanent stations of the global positioning system, LitPOS, has started operating in Lithuania. The main purpose of this network is to solve navigation tasks in real time, anywhere. R. Baniulis, K. Galinauskas, E. Parseliunas, and M. Petniunas (2017) discussed the principle of LitPOS operation and network renewal in 2015. With this network and the right GPNS equipment, users can determine coordinates in real time, even within one centimeter. These technologies are applied in the fields of land management, geodesy, cartography, and real estate cadastre.
The use of one or another satellite system does not guarantee the accuracy of the measurements, as it is also affected by the number and location of the satellites. The so-called PDOP has a direct effect on the measurement results depending on the number of satellites and their position in orbit. The lower the PDOP indicator (the higher the number of satellites), the more accurate the measurement results (Norkus, 2018; Piliciauskaite et al., 2020).
GRPK data consists of the GRPK spatial data set, which consists of spatial (lake polygons and others), linear (road axis lines and others), and point (geodetic base points and others) spatial objects, and a georeferenced base map with a scale of M 1: 10000 and which is based on orthophotographic or space maps (Gudritiene et al., 2015). GRPK data are updated with the help of remote methods when a digital and visual interpretation of orthophotographic maps using the camera method is performed (Gudritiene et al., 2015). Gudritiene and co-authors (2019) conducted research investigating the influence of a cartographer on the updating of spatial or linear data of a georeferenced cadastre. The data of the georeferenced cadastre were also studied by other authors, but none of the authors investigated the possible influence of the cartographer on updating such data. Research has shown that the accuracy of updated geographic reference cadastral and linear data depends on the cartographer, as the interpretation of the orthophotographic map differs depending on the person performing it (Gudritiene et al., 2019).
After analyzing the literature and scientific works on geodetic measurements and their accuracy, it was found that geodetic measurements are the most accurate way to collect data and determine coordinates, as they are direct fieldwork. Also, it is very important to mention that the main law governing spatial and cartographic data is the Law on Geodesy and Cartography. GRPK data need to be as accurate as possible, as they are very widely used and updating is necessary to improve and produce even more accurate data. GRPK data are collected using remote methods, the main method being the camera method, where digital and visual interpretation of the orthophotographic map is performed. The interpretation of the map takes place on the latest orthophoto map.

Methodology of research and materials

Part of the results of the work was prepared using the results obtained by field measurements (geodetic measurements), the interpretation of the orthophotographic map, the methods of graphical data modeling, and comparison and generalization of the obtained results were applied.
The electronic calculator of the Microsoft Office software package Microsoft Office Excel 2010 was used for the processing and systematization of the data collected during the research. GeoMap 2018 and AutoCAD software were used to compare the cartographic data compiled by different methods. To determine the coordinates of the turning points of the geodetic measurements, the building was measured in the area using a

GPNS receiver. The coordinates of the turning points of the buildings of the Georeferenced Base Cadastre (hereinafter - GRPK) and the Orthophotographic Maps (hereinafter - ORT10LT) were determined from the Lithuanian Spatial Information Portal. GRPK spatial data sets contain stable surface natural (lake and pond boundaries) and anthropogenic (building boundaries, road centrelines) data. The data of the building layer PASTAT were selected for the study (Fig. 1).

Figure 1. Graphic and raster examples of analyzed objects (compiled by the authors)

Due to possible inaccuracies, the same turning point was determined three times and the average value of the coordinates of the building turning point was used in the article. Coordinate differences (m) were calculated according to the formulas:

$$\Delta X = X_B - X_A, \quad (1)$$

Here: X_B – Coordinates of geodetic points m; X_A – GRPK or ORT10LT points m.

$$\Delta Y = Y_B - Y_A, \quad (2)$$

Here: ΔY-YkoordinačiųskirtumaiY_B – Coordinates of geodetic points m; Y_A – GRPK or ORT10LT points m.

All X and Y coordinate mismatch values are calculated according to the formula:

$$\Delta i = \sqrt{(X_B - X_A)^2 + (Y_B - Y_A)^2}, \quad (3)$$

Here: Δi – is the magnitude of the mismatch m; X_A, X_B, Y_A, Y_B – coordinates of points m.

The magnitude of the mismatch was calculated for each turning point in the building, and then the total average size of the mismatch is calculated for each building. It is calculated by summing and dividing all turning points by the number of pickets at those turning points.

To evaluate the accuracy of the data, the research methodology was chosen in such a way that the discrepancies of the coordinates provided by GRPK up to half a meter were considered very accurate, as it is a remote method for which high coordinate accuracy is determined. An error of 1 meter is perfectly permissible and such data can be considered to be moderately accurate, they meet the requirements of a map scale of 1: 10,000. For the visual comparison of GRPK and ORT10LT, the coordinates of GRPK and ORT10LT turning points were used, according to which the points were marked on the GRPK map (scale M 1: 10000) and in the latest orthophoto map "ORT10LT (2018-2020) - LR raster orthophotography map".

For the final generalization of the study results, the root mean square error of all single-storey buildings and all two-storey buildings is calculated. It is calculated according to the formula:

$$m = \sqrt{\frac{\sum_{i-1}^{n} \Delta_i^2}{n}}, \quad (4)$$

Here: m – root mean square error m; n – number of turning points units; Δi - the size of the mismatch m.

The article analyzes the buildings located in Kaunas and Alytus district municipalities. In the territory of Alytus district municipality, 20 buildings have been selected for demolition, which are divided into two groups - buildings that are not covered by surface objects and buildings that are covered by surface objects. 10 one-storey buildings and 8 two-storey buildings have been selected in Kaunas District Municipality, of which 15 buildings are residential and 3 non-residential buildings - two warehouses and a hangar. The following data were collected for the research: coordinates of turning points of geodetic survey buildings; Coordinates of building turning points provided by GRPK; ORT10LT coordinates of building turning points; GRPK and ORT10LT graphic image.

Discussions and results

The data collected for all selected buildings were presented in tables, an example of which is given in Tables 1 and 2. Details of other buildings will not be presented in the article, summarized research results will be provided. After comparing the spatial data of the turning points of the object obtained by different methods, the geodetic differences between the coordinates of the building angles and the coordinates of the building angles presented in the GRPK data set were determined, and the size of the discrepancy was calculated (Table 1).

Table 1.

Comparison of X and Y coordinates of geodesically measured turning points of a building located at K. Bielinio Street 24 in Kaunas District Municipality and submitted by GRPK

Geodetic coordinates (m)			Coordinates of points GRPK (m)		X Coordinate differences (m)	Y Coordinate differences (m)	The size of the discrepancy (m)
No	X_A	Y_A	X_B	Y_B	ΔX	ΔY	Δi
1	6089492.00	501541.01	6089492.16	501541.57	0.16	0.56	0.58
2	6089501.69	501536.62	6089502.60	501536.86	0.91	0.24	0.94
3	6089499.98	501533.06	6089500.91	501533.10	0.93	0.04	0.93
4	6089505.45	501530.43	6089506.14	501530.75	0.69	0.32	0.76
5	6089501.45	501521.95	6089502.01	501521.56	0.56	-0.39	0.68
6	6089486.27	501529.11	6089486.33	501528.62	0.06	-0.49	0.49

When comparing geodetically measured coordinates with remotely obtained GRPK coordinates, the magnitude of the mismatch varies from 0.49 m to 0.94 m. The largest discrepancy was found in pickets 2 and 3, and the smallest was less than half a meter in picket 6. The average accuracy of the coordinates of the turning points of the data obtained by the different methods is 0.73 m. Since the size of the discrepancy in all pickets is low and less than 1 meter, we can conclude that the collected data are sufficiently accurate. For a more detailed study, an interpretation was performed on the latest orthophotographic map of the Kaunas district in 2018 (Table 2).

Table 2.

Comparison of X and Y coordinates of geodetically measured and camera-determined coordinates of the turning points of a building located at K. Bielinio Street 24 in Kaunas District Municipality

Geodetic coordinates (m)			Interpretation of the orthophotographic map (m)		X Coordinate differences (m)	Y Coordinate differences (m)	The size of the discrepancy (m)
No	X_A	Y_A	X_B	Y_B	ΔX	ΔY	Δi
1	6089492.00	501541.01	6089492.93	501541.61	0.93	0.6	1.11
2	6089501.69	501536.62	6089502.58	501536.71	0.89	0.09	0.89
3	6089499.98	501533.06	6089501.26	501532.74	1.28	-0.32	1.32
4	6089505.45	501530.43	6089506.42	501530.49	0.97	0.06	0.97
5	6089501.45	501521.95	6089502.05	501521.23	0.60	-0.72	0.94
6	6089486.27	501529.11	6089486.44	501528.38	0.17	-0.73	0.75

The magnitude of the discrepancy was slightly larger. ranging from 0.75 m to 1.32 m. compared to the geodetic coordinates compared to coordinates determined by the camera orthophotographic interpretation. The average

discrepancy between the turning points of the data obtained by the different methods is exactly one meter. There is almost no shadow at this turning point. so the most accurate coordinates and the smallest misalignment are set for this point. The largest discrepancy was found in pickets 1 and 3, which may have been due to the falling shadow at these turning points and the size of the protruding roof cornice. As it can only be detected during the field survey. After analyzing these data, we can state that the specialist who determined the GRPK data using remote sensing methods determined more accurate coordinates than the authors of this work performed the interpretation of the orthophotographic map in a camera way. Comparing the geodetic measured coordinates of all selected buildings in Kaunas District Municipality with the coordinates determined by the camera method of orthophotographic map interpretation. The size of the discrepancy varies from 0.42 m to 1.84 m. When working remotely it was difficult to determine the exact coordinates. Due to a falling shadow and a tree blocking the building's pickets. The average mismatch of the turning points of the data obtained by different methods in all pickets is almost 1 meter - 0.96 m. Summarizing the coordinates determined by the data of the specialist working with GRPK and the X and Y coordinates determined by the authors. It can be stated that the maximum values of the discrepancy are determined at the same turning points. Therefore two main reasons for the size of the discrepancy have been identified: the first falling dark shadow and the second adjacent tree blocking the two corners of the building. After summarizing the data and comparing the geodetic measurements of one-storey buildings with the GRPK data the most accurate coordinates are determined for the second object in Saulėtekio str. 2 E. The total misalignment of the turning points is only 0.72 m. The maximum total size of the misalignment of the turning points is 1.56 m. It is determined for the fourth object located in Krivių str. 5. Comparing the geodetic measurements of one-storey buildings with the authors' interpretation of the orthophotographic map by the camera. The most accurate coordinates were also determined for the second object. The total misalignment of the turning points is only 0.70 m. And the maximum total size of the misalignment of the turning points is 1.72 m. it is determined for the seventh object in Žaisos str. 24. The main reasons for the possible discrepancies identified in the use of the orthophoto map are the poorly oriented orthophoto map. The high contrast of this map and the shadows falling from other objects. Inaccuracies sometimes occurred due to the protruding roof of the building or the abandonment of a large roof and the unnoticed shelter or terrace. Even when determining coordinates remotely. The skills and diligence of the specialist are very important. As the specialist working with GRPK data was more accurate than the author of this work interpreting the map in a camera way. A total of 56 turning points and their coordinates for buildings located in Kaunas District Municipality are analyzed. Based on the data accuracy assessment methodology precise coordinates are determined for 6 turning points. The average coordinate accuracy is determined for 21 turning points. And for more than half of the turning points – 29, inaccurate coordinates exceeding 1 meter error are determined. Thus the exact coordinates account for 10.7%, the average accuracy for 37.5% and the inaccurate coordinates for as much as 51.8%. Annex 3 already contains a table comparing the coordinates determined by the author's chamber method with the coordinates obtained during geodetic measurements. Precise coordinates were found for only 3 turning points, with the most accurate coordinates found at 22 turning points and the most inaccurate coordinates found at more than half of the 31 turning points and 55.4% inaccurate coordinates.

After analyzing the X and Y coordinate differences and mismatch sizes of the two-storey buildings and comparing the geodetic measurements with the GRPK data, the most accurate coordinates were determined for the first object in Pienių str. 1. A total of 56 turning points were also analyzed the fifteenth object located in Žaisos str. The differences and magnitude of the 15 coordinates are the largest, exceeding three meters in some places and the total average of all turning points is as high as 2.45 m. These large discrepancies are due to the protruding roof. Comparing the geodetic measurements of two-storey buildings with the author's interpretation of the orthophotographic map by the camera method. the most accurate coordinates are determined for the seventeenth object in Žaisos str. 24. The total average size of the mismatch at all turning points in this building is 1.02 m. The biggest inaccuracies are found in the 16th Žaisos str. 16. The overall average size of the turning point mismatch in this building is 1.95 m. The use of an orthophoto map has identified the main reasons for these discrepancies. The main reason is also the roof it is too neglected, so it is not clear exactly where the boundaries of the building are. The obtained results are summarized by evaluating the overall accuracy of the turning points of one and two-storey buildings therefore the mean square error is calculated for these turning points (Table 3).

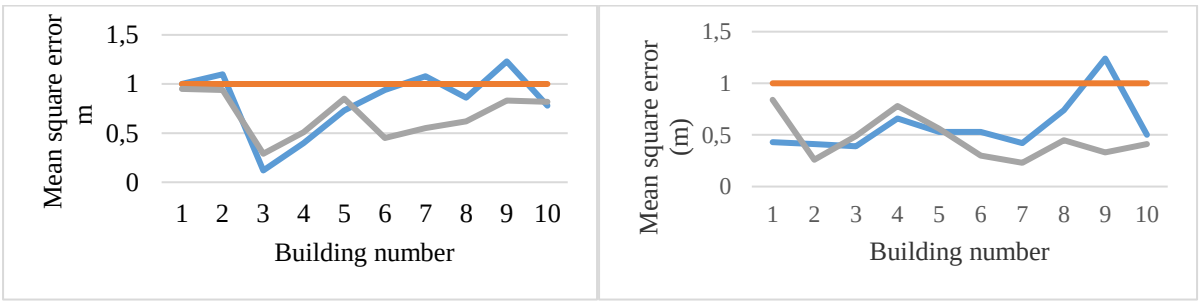
Table 3.

Mean square error of objects analyzed by different methods

The root mean square error		
Number of floors of the building	GRPK data	ORT10LT data
1st floor buildings	1.19	1.21
2st floor buildings	1.62	1.67

A comparison of these buildings by number of storeys shows that single-storey buildings are measured 36% more accurately than two-storey buildings. The camera method was performed by the authors interpreting the orthophotographic map and it was found that the total standard error of one-storey buildings is 1.21 m and that of two-storey buildings is 1.67 m. Comparing these buildings by the number of storeys it was found that single-storey buildings were measured 38% more accurately than two-storey buildings using the chamber method. It was also noted that the specialist working with GRPK data was more accurate in determining the X and Y coordinates of both high-rise buildings. Thus the coordinates of remotely assembled lower buildings are more accurate than the coordinates of taller buildings so it can be argued that due to the central projection.

Analyzing the data of the buildings in Alytus district municipality. The aim was to determine the causes of coordinate errors. GRPK and ORT10LT and geodetic data of the analyzed buildings were divided into two groups - buildings not covered by ground objects. they are in an open area (first group) and buildings covered by high ground objects (trees, shrubs, adjacent structures). The coordinates of the X and Y (Fig. 3) turning angles of the two groups of buildings were compared based on the GRPK and ORT10LT data, which were determined by calculations. Based on the results of the calculations a tolerance limit of 1 m has been set for the analysis as it meets the requirements of M 1: 10000.



a) b)

Figure 2. Mean square error of the X (a) and Y (b) coordinates of the first group of buildings GRPK and ORT10LT (compiled by the authors)

A comparison of the turning angles of the X and Y coordinates of the first group of buildings revealed:

• When comparing geodetic measurements and GRPK data. the mean square error ranged from 0.12 m to 1.23 m. and the mean error is 0.82 m. Comparing the data from geodetic measurements and ORT10LT the mean square error ranged from 0.29 m to 0.95 m. with a mean of 0.68 m.

• When comparing geodetic measurements and GRPK data the mean square error of the Y coordinate ranged from 0.39 m to 1.24 m. with a mean error of 0.59 m. Comparing the data from geodetic measurements and ORT10LT the mean square error ranged from 0.23 m to 0.84 m. with a mean of 0.47 m.

• A comparison of the turning angles of the X and Y coordinates revealed that the X coordinates are more accurate in the ORT10LT as the mean square error of the ORT10LT averaged 0.68 m and the GRPK 0.82 m. The Y coordinates were also found to be more accurate in the ORT10LT, as the mean square error of the ORT10LT averaged 0.47 m and the GRPK 0.59 m.

A comparison of the turning angles of the X and Y coordinates of the second group of buildings revealed:

• When comparing geodetic measurements and GRPK data the mean square error ranged from 0.32 m to 1.67 m. and the mean error is 0.70 m. Comparing the data from geodetic measurements and ORT10LT, the mean square error ranged from 0.27 m to 1.45 m. with a mean of 0.77 m.
• A comparison of the Y-coordinate turning angles revealed that when comparing geodetic measurements and GRPK data, the standard deviation ranged from 0.09 m to 1.12 m with a mean error of 0.57 m. Comparing the data from geodetic measurements and ORT10LT, the mean square error ranged from 0.31 m to 1.01 m, with a mean of 0.61 m.
• A comparison of the turning angles of the X and Y coordinates showed that the X coordinates are more accurate for GRPK, as the mean square error of GRPK averaged 0.70 m and that of ORT10LT was 0.77 m. Y coordinates were also found to be more accurate in GRPK as the mean square error of GRPK averaged 0.57 m and ORT10LT 0.61 m.
The analysis of GRPK and ORT10LT data revealed that the X coordinates are more accurate for the second group of buildings. As the mean square error averaged 0.73 m and for the first group 0.75 m. Y coordinates were also found to be more accurate for the first group of buildings. As the mean square error averaged 0.53 m and for the second group 0.59 m.
The performed research proves that GRPK data are collected by highly specialized specialists. Because comparing the performed ORT10LT interpretation and GRPK data, it was found that GRPK data are more accurate.

Conclusions and proposals

1. 1. After the analysis, it was established that out of 494 analyzed coordinate values in Alytus district municipality, the 1 m discrepancy limit did not exceed 407 coordinates. And the set limit was exceeded by 87 coordinate values. The largest mismatch between the X coordinate value was 2.90 m and the largest Y coordinate value was 1.99 m. The maximum mean square error for the X coordinate was 1.67 m and the smallest was 0.12 m. The maximum standard deviation for the Y coordinate was 1.24 m and the smallest was 0.09 m. Based on the performed calculations it can be stated that the Y coordinates are more accurate because their root means square error is smaller than the root mean square error of the X coordinates. Summarizing the data of turning points of 112 buildings located in Kaunas District Municipality it can be stated that the coordinates of turning points of GRPK 14 buildings are given accurately (with geodetic coordinates up to 50 cm), 38 - medium accuracy (discrepancies with geodetic coordinates do not exceed 1 m) and 60 coordinates are given inaccurate because it exceeds the 1 meter threshold.
2. After interpreting the orthophotographic map and comparing it with the results of geodetic measurements and data provided by GRPK, the following reasons for inaccurate coordinate determination were identified: orthophotographic map orientation inaccuracies, large and dark shadows falling from surrounding objects and covering part of the building, uneven does not allow to determine the exact boundary of the corner of the building. The roofing of the building and the covering of the yard sometimes have similar shades (lack of contrast); tree crowns block part of buildings; poor resolution of orthophoto map (blurred image).
3. GRPK spatial data were found to be more accurate for buildings that are covered by other objects or shadows (second group), and their mean square error averaged 0.63 m. Buildings that are not obscured by other objects or shadows (first group) are represented by the GRPK with less accuracy and have a mean square error of 0.70 m. The accuracy of the GRPK was not affected by the cladding of the buildings, as the mean square error of the buildings of the second group is smaller than that of the buildings of the first group.

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ANALYSIS OF LATVIAN LAND FUND TRANSACTIONS WITH AGRICULTURAL LAND

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Abstract
In order to promote the preservation of agricultural land and the sustainable use of its areas for the needs of agricultural production, on 1 July 2015, the Latvian Land Fund established by the state started operating in Latvia. The Land Fund was established to promote the preservation and use of agricultural land for agricultural purposes in Latvia in the amount of not less than 2 million hectares, involving approximately 0.4 million hectares of agricultural land not previously actively used in active agricultural production.
The operation of the Land Fund is regulated by the Law on Privatization of Land in Rural Areas and the regulations of the Cabinet of Ministers on transactions with agricultural land. Development Finance Institution ALTUM has been approved as the land fund manager.
The Latvian land fund consists of accumulated agricultural land, which is further leased, sold or changed. The main activities of the Land Fund are the purchase of agricultural land, the lease of agricultural land and the sale or exchange of land. The Land Fund buys property from existing owners who are no longer able or for any other reason unable or unwilling to continue to use agricultural land for agricultural activities themselves. The Land Fund is looking for a buyer or manager for the purchased property. For unleased and unsold properties, the fund organizes management - mowing, and bush removal with the aim of keeping agricultural land in good condition, cleaning up agricultural land and returning it to agricultural circulation.
The aim of the study is to analyze the Latvian Land Fund's transactions with agricultural land since the establishment of the Land Fund.
Key words: Latvia, Land fund, land banking, agricultural land, transactions with the land.

Introduction

More than 30 years have passed since the beginning of the land reform (1990), however, this process in Latvia, as in other Central and Eastern European countries, has not been fully completed (Land reform: from ..., 2021). One of the most important tasks of land reform was to ensure the economic use and protection of natural and other resources by reorganizing the legal relations of land use and ownership (Law On Land ..., 1990). This applies in particular to land, especially in agriculture, where it is a major natural resource. Due to the large scale of the land reform and various objective and subjective factors, not all new landowners were able to formalize the land allocated to them. Although in Latvia there was a principle of "privatization through use" in land privatization, which was generally a positive factor, as it ensured a gradual, more reasonable redistribution of land, not all those who wanted land could join the process, as many lacked financial resources, technical skills and experiences (Parsova, Jankava, 2021). Consequently, many areas of agricultural land were set aside, which in turn caused them to remain uncultivated and gradually overgrown with shrubs and low-value trees. According to a study conducted by the Ministry of Agriculture of the Republic of Latvia in 2015 (Šā gada 1.jūlijā..., 2015), in Latvia from approximately 2.3 mln. Only 1.56 million hectares of agricultural land were cultivated. hectares. More than 700 thousand hectares of agricultural land were uncultivated. The study concludes that about half of this uncultivated agricultural land could be returned to agriculture under favorable economic conditions.
Many Western European countries have a long tradition of using land banking services in such cases. The traditional purpose of land banks has been to support agriculture and rural development by reducing land fragmentation and promoting farm expansion. In Western Europe, the goals of land banks have evolved over the past decades and are now used in a multifunctional approach with land consolidation in several countries. In addition to the continuous development of agriculture, land banks in most countries are also widely used in land consolidation projects in connection with the development of various development projects. For example, when expropriating agricultural land from private landowners in connection with infrastructure projects, such as the construction of roads and railways, as well as for nature-related projects, afforestation, land banks are used as a source for compensation for these expropriated areas. In some Western European countries, the land

bank is also applied to land use rights, where farmers who want to manage abandoned, uncultivated land are attracted on preferential terms (FAO, 2022).
On July 1, 2015, the Latvian Land Fund established by the state also started operating in Latvia. It aims to promote the protection of agricultural land, ensure its availability and preservation, as well as its efficient and sustainable use at a national level. The establishment of the Land Fund was presented as one of the state instruments to promote the preservation of agricultural land and the sustainable preservation of these areas, stipulating that not less than 2 million hectares of agricultural land should be preserved in Latvia in the number of hectares, involving about 0.4 million hectares in active agricultural production of previously unused agricultural land (Šā gada 1.jūlijā..., 2015).

Methodology of research and materials

The operation of the Land Fund is regulated by the Law "On Privatization of Land in Rural Areas" and the Regulations of the Cabinet of Ministers on the Procedure for Carrying Out Transactions with Agricultural Land (Regulations Regarding Transactions..., 2014). Development Finance Institution ALTUM has been approved as the Land Fund Manager. The Latvian land fund consists of accumulated agricultural land, which is further leased, sold or changed. The main activities of the Land Fund are the purchase of agricultural land, the lease of agricultural land and the sale or exchange of land. Section 30^2 "Right of Pre-emption to Agricultural Land" of the Law "On Privatization of Land in Rural Areas" stipulates that the land fund is one of the pre-emption persons if real estate is sold, the land area of which is the dominant land use category (On Land Privatization..., 1992). The Land Fund buys property from landowners who are no longer able or for any other reason unable or unwilling to continue to use agricultural land for agricultural activities themselves, and whom themselves express a wish to sell the property to the Land Fund. The Land Fund is looking for a buyer or manager for the purchased property. In turn, the unleased and unsold properties were to be purchased for management services - including mowing, and bush removal with the aim of keeping the agricultural land in good condition, cleaning up the agricultural land and returning it to agricultural circulation.
The Land Fund buys real estate throughout the territory of Latvia that meets certain criteria:

- it can be recovered or maintained for agricultural production;
- agricultural land is more than 50% of the total area of the property;
- the real estate is registered in the Land Register;
- the property has good condition access to the road of national, municipal or local significance;
- there are no restrictions on economic activity for the property;
- there are no buildings and structures on the real estate not registered in the Land Register, the cadastral value of which exceeds 30% of the cadastral value of the property, or which belong to another owner, or cultural monuments;
- the real estate is not in dispute or is not otherwise encumbered with obligations of a material nature;
- all real estate is sold (Šā gada 1.jūlijā..., 2015).

The Land Fund buys property at prices that do not exceed the average market price for equivalent agricultural land in the relevant county or parish.
Without competing with private market participants, the Land Fund enters into economically justified transactions with both natural and legal persons. Any landowner can sell agricultural land to the Land Fund, while natural and legal persons can buy it if they meet the criteria defined in the Law on Privatization of Land in Rural Areas, i.e. the main criterion is the buyer's occupation in agricultural production. Information on land available for sale is available on the fund's website www.altum.lv/zemesfonds. It is determined that if several potential buyers apply, preference is given to the purchase of land in the following order - the last tenant of the land, the bordering neighbour, and the young farmer, while in other cases it is planned to hold an auction among potential buyers.
Both natural and legal persons can lease property from the Land Fund. Lease prices correspond to the average lease prices for agricultural land of a quality corresponding to the market prices in the county and parish of the respective transaction. Properties available for rent are also available on the fund's website.
The Latvian Land Fund also offers reverse lease - sells land with lease and repurchase rights to secure financial resources. In this case, the landowner, when selling his property to the Land Fund, receives a fixed market value estimate for the transaction and 90% of the market value of the transaction, but if he continues to manage the property, he pays a rent of 5% of the transaction amount received. In the case of a reverse lease, the lessee

must repurchase the land at any time within 5 years of the contract is entered into at the market value of the transaction.
Land swaps are also possible. By filling in the exchange application form on the Fund's website, the owner of agricultural land may offer to exchange the agricultural land he owns for one of the properties offered for sale or exchange by the Land Fund, if it is geographically more advantageous for the owner than the existing property. In this case, the Land Fund intends to evaluate the property offered for exchange similarly to the acquisition transactions, determining their compliance with the purpose of the Land Fund, evaluating the usefulness, efficiency, and comparing the prices of both properties.
Pursuant to the above-mentioned regulatory enactments (Regulations Regarding Transactions ..., 2014), the Latvian Land Fund Manager must submit a report on real estate transactions to the Ministry of Agriculture by the 25th day of the first month of the current quarter, indicating the purchase and sale of agricultural land in the previous quarter, the number of exchanges and leases and the area of agricultural land. The Ministry of Agriculture publishes this report on a quarterly basis on the Ministry of Agriculture's website www.zm.gov.lv. At the time of writing, reports on the Latvian Land Fund's transactions with agricultural land for the first five years of its existence were available on this website: from 2016 to 2020.
The aim of the research is to evaluate the Latvian Land Fund's transactions with agricultural land since its establishment in order to find out their impact on the involvement of agricultural land in production.

Discussions and results
In five years, the Latvian Land Fund has carried out a total of 1984 transactions with agricultural land (Table 1). The fund has acquired almost 20 thousand hectares of agricultural land, most of which has been leased. In addition, it should be noted that farmers are happy to use the reverse lease terms, as evidenced by the fact that one third of landowners who have sold land to the Fund retains the lease on their former land but can develop production to acquire necessary funds to redeem later the land from the Fund again. Although this does not indicate the return of unused agricultural land to agriculture, the Land Fund is thus used as a tool for optimizing the farm's cash flow.
In five years, there have been only four cases of land purchases from the Land Fund and only one use of the land exchange situation.

Table 1

Summary of Latvian Land Fund transactions with agricultural land
for the period 2016-2020

No.	Type of transactions	Number of transactions	Agricultural land area, ha	%	
				of the number	from the area
1.	Acquired property	983	19203.00	49.5	51.0
Including reverse leases		*285*	*4953.89*	*29.0*	*25.8*
2.	Sold	4	65.84	0.2	0.2
3.	Swaps	1	13.20	0.1	0.0
4.	Leased	996	18398.43	50.2	48.8
Total		**1984**	**37680.47**	**100.0**	**100.0**
Including reverse leases		*285*	*4953.89*	*14.4*	*13.1*

Source: compiled by the authors from *Latvian land fund reports (2016-2020)*

The total number of transactions and the volumes of land involved in them in the first five years of the Fund's existence are not very satisfactory, as the analysis of the Fund's reports on agricultural land is still far from the expected 0.4 million hectares of unused land in active agricultural production. Despite the fact that the Latvian Land Fund has purchased almost 20 thousand hectares of agricultural land with the aim to involve it in agricultural production, the amount of the reverse lease and the fact that there is no data on how often and in which areas unused agricultural land has purchased the success of this process cannot yet be called. In this

context, the question remains whether the creation of a Land Fund has really been a successful idea or whether it has been given too few resources to have the intended impact.
Assessing the number and volume of transactions by year, it should be noted that their growth is gradual (table 2 and table 3). As can be seen in Table 2, in the first year of its existence (2016) the Fund purchased land in 76 cases, twice a year more such transactions took place, but after four years the number of purchase transactions increased by 4.5 times. A similar trend is observed in transactions with the land areas included in them - every year more and more land areas are included in the Latvian Land Fund, most of which are also actively leased. However, it should be noted that the opportunity to purchase land from the Land Fund or to change land has been used very little. In this regard, more detailed research would be needed as to why this is the case - whether these plots of land are not so promising that tenants do not want to buy them, or for some other reason.

Table 2

Latvian Land Fund transactions with agricultural land
for the period 2016-2020

No.	**Type of transactions**	**Number of transactions by year**				
		2016	**2017**	**2018**	**2019**	**2020**
1.	Acquired property	76	142	174	243	348
Including reverse leases		-	*7*	*34*	*16*	*228*
2.	Sold	1	-	-	3	-
3.	Swaps	-	-	-	1	-
4.	Leased	90	143	162	250	351
Total		**167**	**285**	**336**	**497**	**699**
Including reverse leases		**-**	***7***	***34***	***16***	***228***

Source: compiled by the authors from *Latvian land fund reports (2016-2020)*

Table 3

Volumes of Latvian Land Fund transactions with agricultural land
for the period 2016-2020

No.	**Type of transactions**	**Transaction volumes by years, ha**				
		2016	**2017**	**2018**	**2019**	**2020**
1.	Acquired property	1501.94	2166.40	3605.48	4924.60	7004.58
Including reverse leases		-	*125.76*	*716.90*	*243.85*	*3867.38*
2.	Sold	28.24	-	-	37.60	-
3.	Swaps	-	-	-	13.20	-
4.	Leased	1783.64	2143.65	3206.01	5031.74	6333.57
Total		**3313.64**	**4310.05**	**6711.49**	**10007.14**	**13338.15**
Including reverse leases		**-**	***125.76***	***716.90***	***243.85***	***3867.38***

Source: compiled by the authors from *Latvian land fund reports (2016-2020)*

As can be seen from the data in Tables 2 and 3, the volumes of the reverse lease are also increasing every year. It should be noted that such reverse lease is a new activity in Latvia, which could also explain the situation that in the first year there were no such transactions at all, in the second - there were only 7 cases, but after three years both the number of transactions and the areas included 30 times.
Although, after five years of operation, the total volume of transactions of the Latvian Land Fund is not very significant, a significant acceleration in these activities may indicate the growing popularity of the Land Fund among farmers. Unfortunately, at the time of writing, no more recent data were available for 2021, so no further activities of the Foundation can be concluded. However, taking into account the figures presented in the previous analysis and foreign experience in the establishment and operation of such state land banks, it should be assumed that this process will continue in Latvia as well, as well as create an appropriate application.

In Western Europe, land banking as a process has been known for a long time since the beginning of the last century. Land banks are defined as a set of systematic activities implemented by an institution with a public purpose, performing the intermediate purchase, sale, exchange or lease of land in rural areas in order to increase land mobility, facilitate the development of agricultural land markets, and to pursue public policy objectives related to agricultural and rural development, sustainable land use and implementation of public projects related to nature restoration, environmental protection, climate change and construction of large-scale infrastructure (FAO, 2022). Such activities are guided by the need to increase land mobility, facilitate rural land market development, reduce land abandonment and attain other public objectives. In many Western European countries, land banking is well-known and enjoys a long tradition. For example, in Denmark, France, Germany and Spain, land banks are closely linked to land consolidation projects, especially those related to the construction of large infrastructure structures (roads, railways) and expropriated land. Similarly, in land consolidation solutions, both for agricultural purposes to expand agricultural land and in projects to improve various natural conditions, land banks act as an ecological tool for areas expropriated for reserves and other environmentally important areas. In these cases, the land accumulated in the land banks is used as compensation to the landowners to whom the land is expropriated for such purposes. Land banks have also been established and operate in Lithuania, Poland, the Czech Republic, Croatia and other Eastern European countries.

In Latvia, unfortunately, the Land Bank or the Latvian Land Fund is not linked to land consolidation, as a land consolidation system has not yet been established in Latvia. At the same time, it should be noted that with the increase in production and agricultural land in Latvia, the fragmentation of land holdings is increasing, which farmers are currently tackling on their own - by combining land either through mutual land lease or by purchasing adjacent land as far as possible. The Latvian Land Fund, expanding its activities, could be an important tool for the further arrangement of agricultural land in accordance with the conditions of agricultural production.

Conclusions and proposals

1. As in other Western and Eastern European countries, the Latvian Land Fund established in Latvia has started its operation, which already has five years of experience. In total, the Latvian Land Fund carried out transactions with agricultural land in 1984, acquired almost 20 thousand hectares of agricultural land, most of which was leased.
2. Although the total number of transactions and the volume of land involved in them in the first five years of the Fund's existence is not as large as expected, the number and volume of transactions in agricultural land are increasing every year.
3. Reverse leases are also becoming increasingly popular. However, this situation does not indicate the return of unused agricultural land to agriculture, as the Land Fund is thus mainly used as a tool to optimize the farm's cash flow.
4. There have been very few land purchase and exchange transactions from the Latvian Land Fund. This could be explained by the still small amounts of land in the Latvian Land Fund, which may not always provide farmers with land plots that are advantageous to them.
5. It must be concluded that the goals set at the beginning of the establishment of the Latvian Land Fund - to involve approximately 0.4 million hectares of unused agricultural land in active agricultural production have been too ambitious. In the first five years of the Land Fund's operation, this target has been met by only 5%. In addition, a large part of the Land's real estate transactions cannot be said to involve previously unused agricultural land. This situation requires a broader and more detailed analysis of the involvement of hitherto unused agricultural land in agricultural production, as well as the resources and efficiency of the Land Fund.
6. With the increase in the number of transactions and the volume of land in them, the Latvian Land Fund, similar to Western Europe, could be a good tool for ensuring sustainable rural development and successful agricultural production.

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EVALUATION OF THE QUALITY OF A CHECKERBOARD CAMERA CALIBRATION COMPARED TO A CALIBRATION ON A LABORATORY TEST FIELD

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Abstract

For photogrammetric works, a fundamental issue is the determination of camera internal orientation parameters (IOP). Without camera calibration, it is difficult to imagine a correct adjustment of the image network. Many industries use non-metric cameras, ranging from automatics and robotics, to heritage inventories, and the increasingly popular social mapping phenomenon uses low-budget cameras. Many different calibration methods exist, but dedicated calibration fields are commonly replaced by fast in-plane calibration with regular patterns. The main goal of this research is to verify the thesis that calibrating cameras on a checkerboard gives worse results in determining IOP than on a laboratory test field which may translate into the resulting model. For the purpose of this study, a special field was constructed, allowing calibration of the instruments on the basis of the network solution by the bundle adjustment. Unlike classical 2D fields, the field is equipped with a cork background providing a good base for matching and automatically detecting measurement marks. Calibration results were compared with calibration performed on a checkerboard implemented in MATLAB Camera Calibration Toolbox. In order to determine IOP in MATLAB, images of the checkerboard must be taken in such a way, that the whole pattern fits into the frame, otherwise toolbox defines the incorrectly coordinate system, which has a bad impact on calibration results. Moreover, the determined parameters have several times larger standard deviations than those determined in the laboratory test field, which confirms the thesis.

Key words: camera calibration, internal orientation parameters, checkerboard, test field.

Introduction

The camera internal orientation parameters (focal length and principal point coordinates) are an essential element in photogrammetric works. The calibration process is necessary to obtain metric information about three-dimensional reality using two-dimensional images. This process aims to describe a projection model that relates to both coordinate systems: the terrain system and the image system (Oniga et.al., 2018). Cameras can be calibrated for their geometric quality as well as their radiometric quality, and many times this process can be performed on a single calibration field.

Many calibration methods can be found in the literature (Remondino et.al., 2006; Zhang, 2004) divided by, for example, the functional model, estimation and optimization techniques, or the dimension of the calibration field. Laboratory calibration fields can be either internal or external. Photogrammetric solutions are largely based on the collinearity equation proposed by (Brown, 1968) while in computer vision techniques the use of homography is more popular (Kolecki et.al., 2020).

A mathematical interpretation of calibration based on the collinearity equation has been used for over 50 years. A perfect realization of the central projection is practically impossible due to systematic errors resulting from camera design (e.g., lens mounting errors). In order to minimize the influence of these errors, the Additional Parameters (AP) started to be determined (Brown, 1971), Considering the AP we obtain a collinearity equation with eight parameters (Luhmann et.al., 2016) form:

$$x' = c_x - f * \frac{R_{11}(X - X_0) + R_{21}(Y - Y_0) + R_{31}(Z - Z_0)}{R_{13}(X - X_0) + R_{23}(Y - Y_0) + R_{33}(Z - Z_0)} + x(k_1 r^2 + k_2 r^4 + k_3 r^6) + p_1(r^2 + 2x^2) + 2p_2 x$$
$$y' = c_y - f * \frac{R_{12}(X - X_0) + R_{22}(Y - Y_0) + R_{32}(Z - Z_0)}{R_{13}(X - X_0) + R_{23}(Y - Y_0) + R_{33}(Z - Z_0)} + x(k_1 r^2 + k_2 r^4 + k_3 r^6) + p_2(r^2 + 2y^2) + 2p_1 xy \quad (1)$$

where:

c_x, c_y - coordinates of the principal point in the camera system

x,y - coordinates of the observed point in the camera system

f – focal length
R_{ij} – elements of the rotation matrix R
X_0,Y_0,Z_0 - coordinates of the principal point in the terrain system
X,Y,Z - coordinates of the observed point in the terrain system
k_1,k_2,k_3,p_1,p_2 - radial (k_i) and tangential (p_i) distortion parameters
r – radial radius

It is possible to extend the above model with two components (b_1,b_2) related to the non-orthogonality of the image layout axis. One direction of scale change must be chosen to go from a rectangular pixel to a square one.
Structure-from-Motion (SfM) is a relatively low-cost method used in photogrammetric software whose main task is to reconstruct the photographed scene. It is based on the basic idea of stereoscopy, that is, the reconstruction of three-dimensional reality from a series of overlapping and shifted images (Westoby et.al., 2012). The main advantage of SfM is that it does not require knowledge of the IOP of successive images , the internal orientation of the camera (including distortion), and Ground Control Points (GCP) are only responsible for giving scale and georeferencing to the model. This is due to the implemented SIFT algorithm, which is responsible for detecting similarities in images burdened by longitudinal and transverse parallax. Moreover, as a result of SfM, the camera parameters are determined. An analysis of the successive steps of the method along with their mathematical aspect was presented by (Schonberger, Frham, 2016). First, consecutive images are analyzed for overlap. Then similarities are searched for in three steps. Extraction involves the detection of local image features. They should be radiometrically as well as geometrically invariant so that it is possible to recognize them on many frames. In the next step, matching is performed, which is a search of the images to find a match of features between them. Then, potential overlapping images are verified, since the matching is based on appearance, it is necessary to check whether the same features are definitely related to the same points in the scene. This involves trying to estimate a transformation that would provide a mapping of feature points between images using projective geometry. The result of this step is a so-called scene graph with frames as nodes and verified pairs of photos as edges.
As proposed by (Zhang, 2000), checkerboard-based calibration has been implemented by implementing this solution in many software such as MATLAB or OpenCV. Due to its low cost and availability, it has become a widely used method displacing the classical approach. Unlike the methods based on the collinearity equation, it is not necessary to know any terrain coordinates; the system is determined based on the arrangement of squares in a chessboard.
Due to the differences in the two methods, it was decided to calibrate the same instrument by two methods, compare and evaluate the calibration results.

Methodology of research and materials

The main step was to analyze the literature on available calibration methods. On the basis of the gained knowledge, it was decided to construct a special two-dimensional calibration field, which allowed to determine the camera calibration based on the solution of the image network using the bundle adjustment method and Structure from Motion (SfM) strategy. A Nikon D5200 camera with a 20 mm lens was tested during the study. Given the characteristics of the SfM strategy, the primary goal was to find a suitable background that would make a good matching base. Many materials were tested: topographic maps, fabrics with characteristic weave, and cork, which finally turned out to be the best and, at the same time, relatively cheap solution. Due to the least regular and repeating structure, several photographs of cork provide an adequate number of ties and, consequently, a high overabundance of observations in the adjustment.
The calibration space was created from two mirror-like zones. Each of them consists of a cork sheet of dimensions about 2m x 1m with a grid of 11 x 4 points. Between them, there is an additional narrow space enriched with a column of markers. To optimize the calibration process, markers automatically detected in Agisoft Metashape software were used. Finally, the field took the form of an almost regular 11 x 9 grid with an additional 8 markers on each diagonal (Figure 1).
The research tested what minimum size of markers can be used for the algorithm to be able to identify them in images taken at a certain distance from the field.
To ensure adequate accuracy of the photogrammetric grid, it was assumed that the determination of spatial coordinates of all markers in the local system would be performed in such a way that the average error of their

position in space would not exceed ±0.3 mm. The geodetic survey scheme is discussed in chapter 3.2 of the publication (Kolecki et.al., 2020). constituted the basis for the target measurement.
Photographs of the field were originally planned based on the proposal (Acka, Gruen 2009,) with a slight modification - it was assumed that in the case of the tested camera the pixels of the matrix are square and there is no non-orthogonality of the image axes, so the central images rotated successively by 90° were abandoned. Originally it was assumed that 3 images would be taken in 3 rows, but this option proved to be ineffective due to too low mutual coverage of the images. Therefore, the central image was replaced by two images taken straight ahead, each covering about 70% of the field width. Finally, a registration scheme of 12 images (3 series of 4 images each) was worked out, in the order of left, center left, center right, and right.

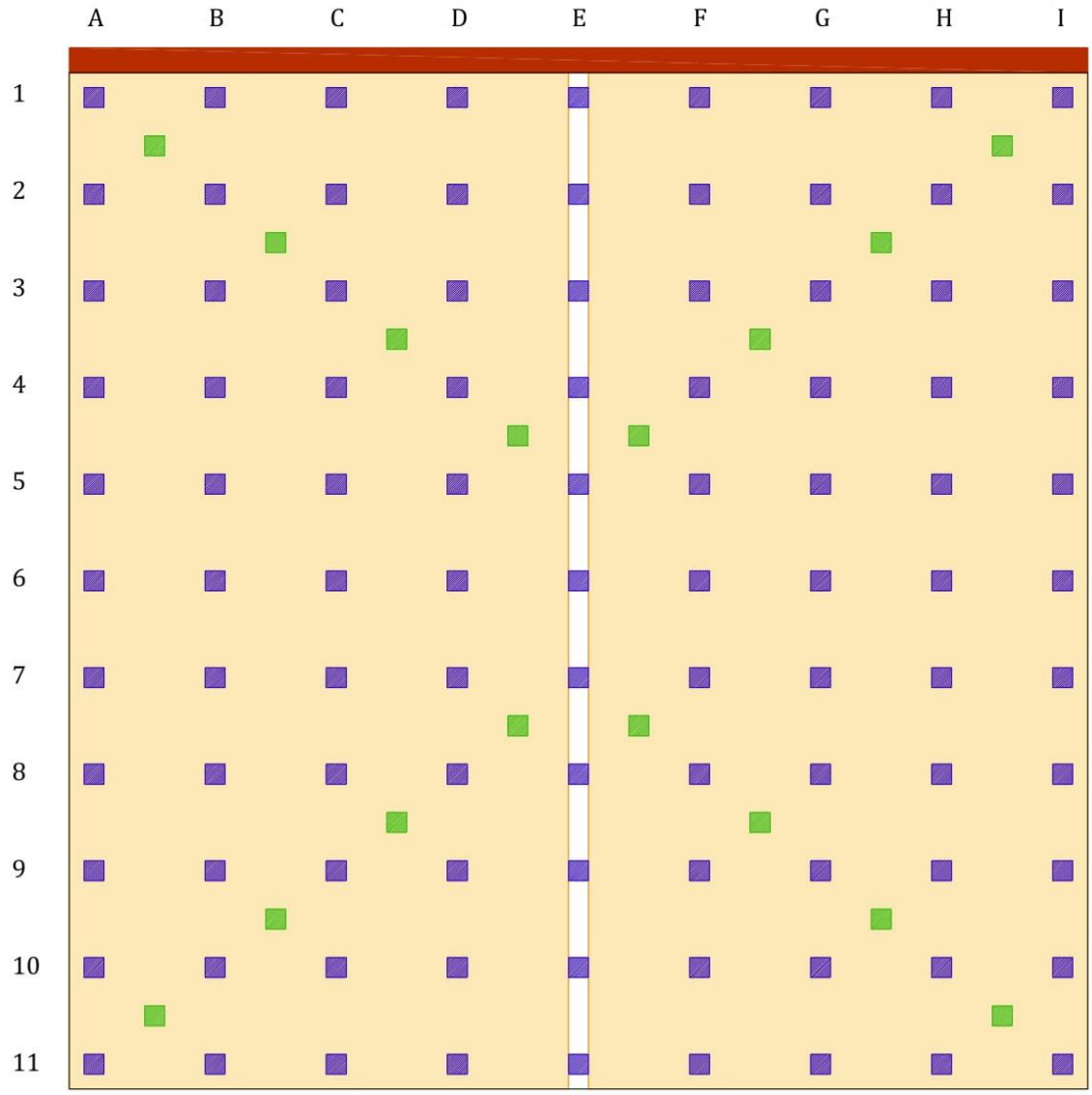

Fig. 1 Project of calibration field design: blue – markers network, green – additional markers, beige– cork sheet, brown – clamping strip

As the basis of the study, Agisoft Metashape Professional software was used. This tool is used for three-dimensional reconstruction from any set of photos provided that there is a mutual overlap between consecutive shots. Whether the final product is to be a textured object model or exterior block orientation elements, the first step is always to *Align photos*. This process consists of finding homology points in consecutive photos based on the SfM method. The result is a pre-aligned network of photos and a cloud of tie points which is the basis for the self-calibration of the camera. The program allows one to choose which lens distortion parameters are

to be modeled during the adjustment. To finally align the image network using the bundle adjustment method, it is necessary to georeference the images by pointing to points with known field coordinates or by using the scale bars method. In the case of pointing, it is important to decide which points will be the Check Points (CHP), i.e. those that do not take part in the adjustment directly, but during calculations, spatial coordinates are determined for them. The differences between the aligned position of the points and their nominal coordinates are the real measure of the accuracy obtained at the site, and thus they constitute the quality of the whole aerotriangulation. In this study, the influence of the ratio of the number of Ground Control Points (GCP) to the number of CHP on the camera distortion parameters was analyzed.

The checkerboard calibration was performed using the Camera Calibration Toolbox in MATLAB. It is based on Zhang's solution (Zhang 2000) which assumes photographing an ideal plane, which is not always fulfilled in reality. The recommendation is to take 10-20 photos of the checkerboard (either printed or displayed on the screen) from different perspectives. While loading the photos into the toolbox, choose the parameters to be determined (distortion coefficients k_1, k_2, k_3 p_1, p_2). The algorithm searches for checkerboard corners on the photos and defines a coordinate system in one of them. Calibration results can be evaluated based on the determined parameters with standard deviations, as well as based on graphs.

Discussions and results

The core of the work was the installation of the field on the wall. An important aspect was to minimize the area occupied by the markers on the cork. It was decided that the markers with a center radius of 3.5 mm would be glued on 4 cm x 4 cm rubber pads. To provide them with greater stability each pad was fixed with screws (Figure 2).

Fig. 2. Example of marker stabilization

The next step involved determining the field coordinates of the markers. For this purpose, a classical tachymetric survey was performed from 2 stations parallel to the calibration field. The coordinates were determined using angular-linear intersection. The images were then registered and aligned using the bundle adjustment method. A tie point cloud containing more than 18,000 points (Figure 3) formed the basis for determining IOP along with standard deviations.

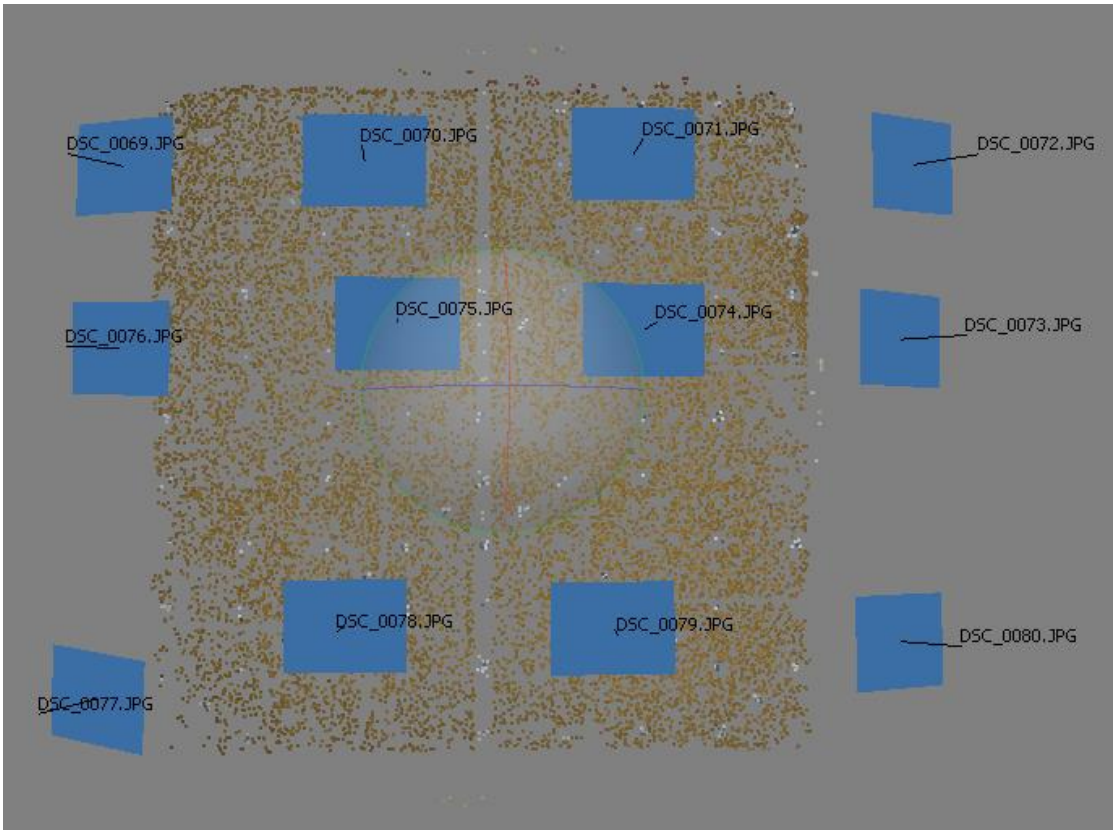

Fig. 3 Tie points cloud with the location of images.

The effect of a systematic reduction in the number of Ground Control Points on the determined IOP was analyzed in this study. Based on 9 variants, it was found that both at 90 GCP (25 CHP) and 15 GCP (100 CHP), results within 0.5 mm spatial error for CHP can be obtained. Therefore, it was decided to conduct analyses with a smaller number of GCP. Results are in (Table 1).

Table 1.

Interior orientation parameters from bundle adjustment with standard deviations.

IOP	Value [pix]	St. Dev. [pix]
f_y	5278.63	0.25
c_x	10.36	0.25
c_y	-17.79	0.22
k_1	-0.11460	0.0003
k_2	0.11150	0.0013
k_3	-0.04110	0.0019
p_1	0.00019	0.00001
p_2	-0.00011	0.00001

Calibration in MATLAB is very simple - it comes down to taking pictures of the checkerboard, loading them, and running the toolbox. The determination of camera parameters is done automatically and practically without any user intervention. The main problem of calibration in this program is the detection of the coordinate system. If the images of the checkerboard are taken at a too large angle, the algorithm misinterprets the origin of the coordinate system and the direction of its axis (Figure 4). During the research, this problem was encountered, so some of the images were excluded from the research.

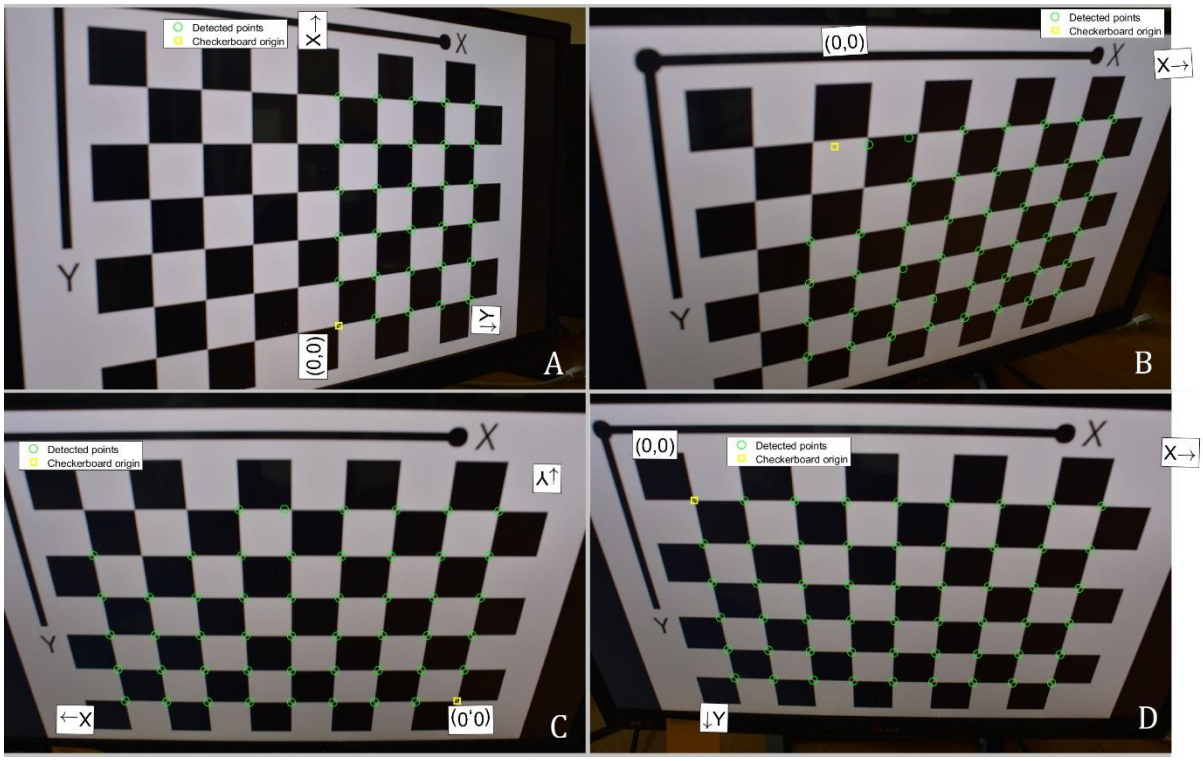

Fig. 4 Identification of coordinate system: A, B, C - incorrect, D – correct

Because the distortion depends on the radial radius (the longer the radius, the bigger the distortion), it is important that the pattern is on the whole surface of the photo, not only in its center. The program can deal mainly with photos where the checkerboard is located in the center of the frame. IOP estimation in such a case is deformed because it is based on smaller radial displacements located closer to the principal point. Because of that, the information about real distortion at the edges of the photo is lost.

Table 2.

Interior orientation parameters from MATLAB with standard deviations

IOP	Value [pix]	St. Dev. [pix]
f_x	5307.55	5.98
f_y	5306.95	6.00
c_x	3021.60	5.45
c_y	1987.57	3.95
k_1	-0.11919	0.008
k_2	0.13384	0.071
k_3	-0.11735	0.186
p_1	-0.00036	0.0002
p_2	0.00022	0.0003

Comparing the results from both solutions (Table 1, Table 2), the first thing that can be noticed is that the toolbox determines separately the focal length in the X and Y axis direction, while from the bundle solution we obtain only one overall focal length value.

The differences in the values of coordinates of the principal point are disturbing. They are the effect of differently hooked background coordinate systems in both programs. For the Agisoft system origin is located in the geometric center of the frame (X axis right, Y axis up) while in the MATLAB system is hooked in the upper left corner (X axis right, Y axis down). After conversion to a common coordinate system (Table 3), similar results are obtained.

Table 3.

Coordinates the principal point in the common coordinate system.

Principal point	Bundle adjustment		Checkerboard	
	Value [pix]	**St. Dev. [pix]**	**Value [pix]**	**St. Dev. [pix]**
c_x	10.36	0.25	21.60	5.45
c_y	-17.79	0.22	-12.43	3.95

Analyzing the radial distortion coefficients it is noticeable that the signs between the solutions are consistent. In the case of tangential distortion, the signs of coefficients are opposite, but due to the very small values of these parameters, it can be considered that their influence on the total distortion is minimal.
The main conclusion of the study proving the disadvantage of the results from MATLAB which are many times higher standard deviations than in the case of field calibration. This is true for all parameters determined. Note, however, that in the case of bundle adjustment there is a very large overabundance of observations relative to the unknowns due to SfM (each tie point in the image contributes 2 equations to the solution). In the case of the checkerboard, the number of observations is much smaller, and thus solving the equations is more difficult.

Conclusions and proposals

The resulting product of a photogrammetric study depends heavily on camera calibration. Introducing incorrect or questionable quality IOP can result in distorted adjustment and consequently incorrect scene reconstruction. Both methods used during the study have different characteristics. The calibration on the field is based on the use of the collinearity equation while the checkerboard is based on the use of homography.
However, based on the research performed, the widespread use of checkerboard calibration is risky. The obvious advantage is the ease and speed of performing such calibration. IOP determined by this method is characterized by much larger standard deviations than in the case of laboratory field calibration. Moreover, when taking checkerboard pictures, it is not possible to take them at a too big angle while keeping the pattern within the whole frame. Images with a checkerboard pattern only in the center of the shot may deform the results and lower the actual values of distortion coefficients.
Creating a laboratory test field is very time consuming, nevertheless calibration results from a bundle adjustment that takes into account SfM are far more reliable. The overwhelming advantage of this method is the huge number of observations included in the alignment. Due to the coded marks, the calibration process is greatly accelerated but still requires more user intervention than with the toolbox. When comparing the accuracy of the IOP's, it is clear that the effort put into a professional calibration on the test field results in more accurate values.

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THE IMPACT OF THE EFFICIENCY OF ADMINISTRATION OF TERRITORIAL PLANNING PROCESSES ON THE DEVELOPMENT OF TERRITORIES: CASE STUDY OF PAGĖGIAI MUNICIPALITY, LITHUANIA

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Abstract
Recently, the opinion has been expressed that the phasing of the processes of preparation of territorial planning documents, depending on the institution that administers it, hinders the processes of preparation of territorial planning documents by established procedural actions. The aim of the article is to evaluate the impact of the efficiency of the administration of territorial planning processes on the development of territories. The object of the research is the complex and special territorial planning documents prepared in the territory of Pagėgiai municipality. Pagėgiai municipality was chosen because the preparation of planning documents in the municipality has slowed down recently, therefore it is important to assess the efficiency of administration of the prepared territorial planning document processes, possible impact on further territorial development, and provide recommendations to ensure more efficient and faster territorial development. During the research, it was established that during the period between the years 2010-2020 only 1 state-level territorial planning document was registered in the territory of Pagėgiai municipality (i.e. 0.69% of those registered in the Republic of Lithuania and 14.29% in Tauragė County). 7 (i.e. 0.52% of those registered in the Republic of Lithuania and 18.42% of those registered in Tauragė County) were registered in the municipality at the municipal level. Territorial planning documents were registered at the local level (i.e. 0.22% of those registered in the Republic of Lithuania and 5.4% in Tauragė County). The analysis of the processes of the prepared planning documents and the interviews of experts revealed that the planning procedures performed by the administering authorities are inefficient: not all the administering authorities consistently carry out the assigned procedures, delay or evaluating the planned decisions within the legal deadline. According to experts, the reason for the inefficient performance of procedures is the lack of human resources in the administering institutions or their inadequate competence. As a result, the improperly performed procedures of territorial planning documents have a negative impact on the planned territory, slow down its development, or the most suitable possible development direction of the planned territory has not been assessed. After performing a multi-criteria analysis of the prepared territorial planning documents, it was established that in the period under review, the most effective document of complex territorial planning was prepared in the territory of Pagėgiai municipality - "Adjustment of the detailed plan of the prepared territory in Vilniaus st. 16 A, Pagėgiai". The rating indicator was 0.0806. The document of complex territorial planning "Adjustment of Pagėgiai city comprehensive plan" stood out with the lowest efficiency, the rating indicator was - 0.0676.
Key words: territorial planning, efficiency, administration.

Introduction

Territorial planning affects society as a whole, and the economic, ecological (Gustafsson et al, 2019) and territorial social development depend on it. Territorial planning is one of the most important instruments managed and planned by each state, which provides an opportunity to organize diverse activities in the planned territory in a coherent and efficient manner (Tiškus, 2010). It reflects the economic, social and cultural literacy of the country. Optimal territorial planning promotes the country's economic growth and has an impact on improving the well-being of the population (Darham, Mahasiswa, 2019) and economic development, investment attraction in the territory (Marks-Bielska and Kurowska, 2017; Marks-Bielska et al, 2020).

Recently, the opinion has been expressed in the society that the phasing of the processes and procedures for the preparation of territorial planning documents, depending on the institution that administers it, hinders the processes for the preparation of territorial planning documents through established procedural actions. The preparation processes of territorial planning documents are artificially delayed, the coordination procedures take much longer than provided for in the legal acts, and the legal acts regulating territorial planning are difficult to implement, which negatively impacts the administrative processes. For these reasons, the development of territories is slowing down, as territorial planning documents are being prepared for a longer period of time than is expected, which is why the investment in the planned development of territories is lost (Blotnis, 2018). Territorial planning processes need to be implemented in a way that does not become bureaucratic but

contributes to the country's territorial development (Martinez, 2017). According to A. Višnevskaja (2009), the processes of organizing territorial planning in Lithuania are partially inefficient, take longer than provided for in legal acts, are inflexible, and some of the functions of institutions are duplicated. Comparing the efficiency of the German, Polish and Lithuanian planning systems, it can be seen that according to the territorial planning policy, Germany is in the first place, Poland in the second place, and Lithuania in the third place, therefore it is necessary to improve the Lithuanian territorial planning system.

In order to create a harmonized and effective territorial planning system, it is necessary to ensure a legal framework that is fully harmonized at all levels of planning. In order to achieve effective territorial development, it is expedient to involve the whole society, and public and private sectors in the preparation and implementation of solutions in territorial planning documents (Maksin, 2014).

When planning territories, it is necessary to set priorities for the use of resources, assess each planned territory, and its peculiarities and determine the direction of development of the territory in the most efficient way. Effective space planning reduces damage to nature and society. Territorial planning must be inseparable from the sustainable and efficient development of territories (Ovchinnikova, 2016).

Territorial planning must meet the needs of society, but nature must also be preserved in a way that conserves and uses its resources sustainably. It is also necessary to reconcile planning with socio-economic development, taking into account scientific, social and political aspects - only then can territorial planning be effective, i.e. when all areas directly or indirectly affected by territorial planning are taken into account (Angers et al., 2020). L. Staiano et al. (2020), based on the example of South America, argue that territorial planning has a significant impact on land use and land cover change and that territorial planning must take into account the consequences of the decisions made for both the ecosystem and human well-being.

The aim of the research is to evaluate the impact of the efficiency of the administration of territorial planning processes on the development of territories.

Methodology of research and materials

The study analyzes the processes of preparation and implementation of complex and special territorial planning documents prepared in the territory of Pagėgiai municipality, their impact on the planned territories. Pagėgiai municipality was chosen because according to the data of the Register of Territorial Planning Documents (hereinafter - TPDR), since 2010, only 3 state, 8 municipal, 81 local levels special and / or complex territorial planning documents have been registered in the territory of Pagėgiai municipality. However, during the last 5 years, only 2 states, 3 municipal and 16 local level special and / or complex territorial planning documents have been prepared in the territory of Pagėgiai municipality. As can be seen from the above-mentioned numbers, a slowdown in the preparation of territorial planning documents is observed in the territory of Pagėgiai municipality, therefore it is important to analyze the efficiency of administration of prepared territorial planning documents, its possible impact on further territorial development and provides recommendations to ensure faster and more efficient territorial development.

Pagėgiai municipality is an administrative unit of the territory in western Lithuania, bordering the municipalities of Tauragė, Jurbarkas, Šilutė districts and the Russian Federation, the center of the municipality is the city of Pagėgiai. The total area of the municipality is about 537 km^2, the municipality has 5 elderships: Lumpėnai, Pagėgiai, Vilkyškiai, Stoniškės and Natkiškės. According to the data of the State Enterprise Center of Registers, 2 towns, 1 township, and 99 villages were registered in the municipality.

The study performed a detailed statistical analysis of special and complex territorial planning documents prepared by Pagėgiai municipality in 2010–2020, and assessed the administration of the processes of territorial planning documents prepared in the territory of the municipality. During the analysis of the administrative processes for the preparation of the prepared territorial planning documents, the administrative processes and procedures for the preparation of the territorial planning documents prepared since 2015 were assessed. The sample of the study from 2015 has been determined taking into account that TPDRIS has been operating in Lithuania only since October 5, 2015, and it is currently the only source, where all approved spatial planning documents and their essential solutions can be found. The study identifies the problems arising in the field of territorial planning and their impact on the further development of territories. Specialists / experts of institutions administering territorial planning processes were interviewed in the 4th quarter of 2021 and the 1st quarter of 2022 using a structured interview method. Three of them work in Pagėgiai municipality administration and two - in Kaunas district municipality administration. The opinion of the drafters of territorial planning documents

was assessed by interviewing three specialists of UAB Kelprojektas. A total of 8 experts participated in the structured interview.

For statistical analysis, data were obtained from the TPDR. For a detailed evaluation of complex and special territorial planning documents, data were obtained from the Territorial Planning Document Preparation Information System (hereinafter - TPDRIS).

The aim of the multi-criteria analysis was to determine the most efficiently prepared territorial planning document in the territory of Pagėgiai municipality since 2015, in terms of administration of processes and procedures, and having a clear positive value for further development of the planned territory. PROMETHEE software was selected for the analysis and the following criteria were used (Table 1).

Table 1

Criteria for multi-criteria analysis to determine the most effective prepared territorial planning document (Source: compiled by the authors)

Criterion	Justification of the criterion	Unit of measurement
Duration of preparation of the territorial planning document	The duration of the preparation of territorial planning documents affects the costs of the preparation of documents (material and / or human resources). The shorter the preparation time of the planning document, the more rational the preparation of the territorial planning document, and the more efficient the process. The solutions of the territorial planning document are determined taking into account the sustainable environment, and the conflict of interest is avoided which prolongs the preparation time.	Months (months)
Involvement of the public in the preparation of territorial planning solutions and proposals	Territorial planning becomes more effective when the public is involved in the process of drafting it and expresses its position on the issue. The received proposals help to form more efficient and environmentally acceptable solutions for the document being prepared, which will have a positive impact on the planned territory in the future.	Yes/No
Ecological, economic, and social well-being have been taken into account when planning the territories	Territorial planning becomes effective when all areas (natural resources, landscape, socio-economic links) that are directly or indirectly affected by territorial planning are taken into account, then territorial development becomes fully sustainable through the implementation of planned solutions.	Yes/No
An environmental impact assessment or selection has been carried out	Territorial planning becomes effective when the impact of the adopted decisions on the planned territory in the future is assessed; when planning the territories, it is necessary to take into account the consequences of the adopted decisions on land use and changes in its cover.	Yes/No
The development of engineering infrastructure is planned	In order to achieve effective territorial development by preparing territorial planning documents (comprehensive plans, special and detailed plans), which indicate the development directions of the territory when planning residential areas, it is necessary to provide for the development and redevelopment of engineering infrastructure.	Yes/No
Size of the planned territory	The size of the planned territory influences the efficient development of the territories. The larger the planned territory, the more effective the planning becomes in the future perspective because during the planning process it is possible	Hectares (ha)

	to comprehensively assess the planned territory and plan larger development directions. Meanwhile, the administrative costs of planning procedures remain the same as for planning a smaller territory.	
A re-coordination of the territorial planning document has been carried out	Re-coordination of the territorial planning document with the institutions prolongs the time of preparation of the territorial planning document being prepared, according to which the planned territory is negatively affected and its development is slowed down. The re-coordination of the solutions of the territorial planning document doubles the administration of procedures and the irrational use of human and material resources.	Yes/No
Automatic coordination of the territorial planning document has been performed or the last day of coordination has been agreed	Automatic coordination of territorial planning documents may have a negative impact on the further development of territorial plans, as the impact of the decisions of the planning document on the planned territory has not been assessed by the responsible authority. If the coordination is carried out on the last day, it is likely that the responsible authorities will not fully assess the planned solutions, which will make the development of the planned territory inefficient or even potentially unfavorable for the environment.	Yes/No
Areas of planning	Effective development of territories is when the planning of the territory takes into account as many planning areas as possible, the comprehensively planned territory has a positive impact on its development when planning investments and the development opportunities of the territory can be foreseen.	Units

The numerical values of the criteria were generated by evaluating the solutions of the prepared territorial planning documents obtained from TPDRIS and TPDR. The systematized data were combined into the decision analysis method PROMETHEE. In the course of the multi-criteria analysis, the directions of the criteria were determined, and they were selected taking into account the usefulness or uselessness of the criterion for the implementation of the set goal of the analysis (Table 2).

Table 2

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

Planning document	Criterion*								
	1	2	3	4	5	6	7	8	9
	Min	Max	Max	Max	Max	Max	Min	Min	Max
Coordination of the detailed plan of the prepared territory in Vilniaus Str. 16 A, Pagėgiai	8.7	No	Yes	No	Yes	0.3	No	No	2
Coordination of Pagėgiai city comprehensive plan	17.1	No	Yes	No	Yes	668.5	No	Yes	5
The Rambynas Regional Park Planning Scheme (boundary and management plans)	23.7	Yes	Yes	No	Yes	4864.9	Yes	Yes	6
Engineering infrastructure development plan for the special state electricity power system synchronization project “Construction of 330 kV power transmission line Kruonis HPP – Bitėnai”	21.4	No	Yes	Yes	Yes	750.8	No	Yes	2
Engineering infrastructure development plan for the special state electricity system	21.4	No	Yes	Yes	Yes	1035.2	No	Yes	2

synchronization project "Construction of 330 kV power transmission line Darbėnai – Bitėnai"									

*1- Duration of preparation of the territorial planning document; 2 - involvement of the public in the preparation of territorial planning solutions and proposals; 3 - ecological, economic and social well-being has been taken into account in the planning of the territory; 4 - environmental impact assessment or selection has been performed; 5 - development of engineering infrastructure is planned; 6 – the size of the planned territory; 7 - re-coordination of the territorial planning document was performed; 8 - automatic coordination of the territorial planning document has been performed or the last day of coordination has been agreed; 9 - planning areas

Based on the obtained results, the alternative selected to implement the goal / objective of the multi-criteria analysis, the recommended Q and P values of the software used, and the methodology for the evaluation of the criteria were selected (Table 3).

Table 3

Thresholds and priority functions used in multi-criteria analysis (Source: compiled by the authors)

Criterion	Q	P	Priority function
Duration of preparation of the territorial planning document	4.89	11.75	Linear
Involvement of the public in the preparation of territorial planning solutions and proposals	Yes/No	Yes/No	Normal
Ecological, economic and social well-being have been taken into account in the planning	Yes/No	Yes/No	Normal
An environmental impact assessment or selection has been carried out	Yes/No	Yes/No	Normal
The development of engineering infrastructure is planned	Yes/No	Yes/No	Normal
Size of the planned territory	1854,68	3873,86	Linear
A re-coordination of the territorial planning document has been carried out	Yes/No	Yes/No	Normal
Automatic coordination of the territorial planning document has been performed or the last day of coordination has been agreed	Yes/No	Yes/No	Normal
Areas of planning	1.66	3.86	Linear

After the research and the achievement of the research goal, the relevant research conclusions were formulated based on the obtained results.

Discussions and results

According to the data of the TPDR, from 2010 to 2020, 1 state level territorial planning document was registered in the territory of Pagėgiai municipality, which accounted for 0.69% of the state level planning documents registered in the Republic of Lithuania and 14.29% in Tauragė County (Table 4).

Table 4

Number of territorial planning documents registered in 2010-2020 by levels of territorial planning documents (Source: compiled by the authors using TPDR data)

State level			Municipal level			Local level		
The Republic of Lithuania	Tauragė County	Pagėgiai municipality	RL	Tauragė County	Pagėgiai municipality	The Republic of Lithuania	Tauragė County	Pagėgiai municipality
144	7	1	1340	38	7	35713	1473	80

The data presented in Table 4 show that 7 municipal territorial planning documents were registered in Pagėgiai municipality during the study period, these registered documents make up 0.52% of the municipal planning documents registered in the Republic of Lithuania and 18.42% in Tauragė County. 80 local level documents were registered in the municipality, which accounted for 0.22% of the local level territorial planning documents registered in the Republic of Lithuania and 5.4% in Tauragė County.

During the detailed statistical analysis of complex and special territorial planning documents prepared in the territory of Pagėgiai municipality, it was noticed, that the amount of both special and complex territorial planning documents prepared in the analyzed period is unstable, changing every year (Figure 1).

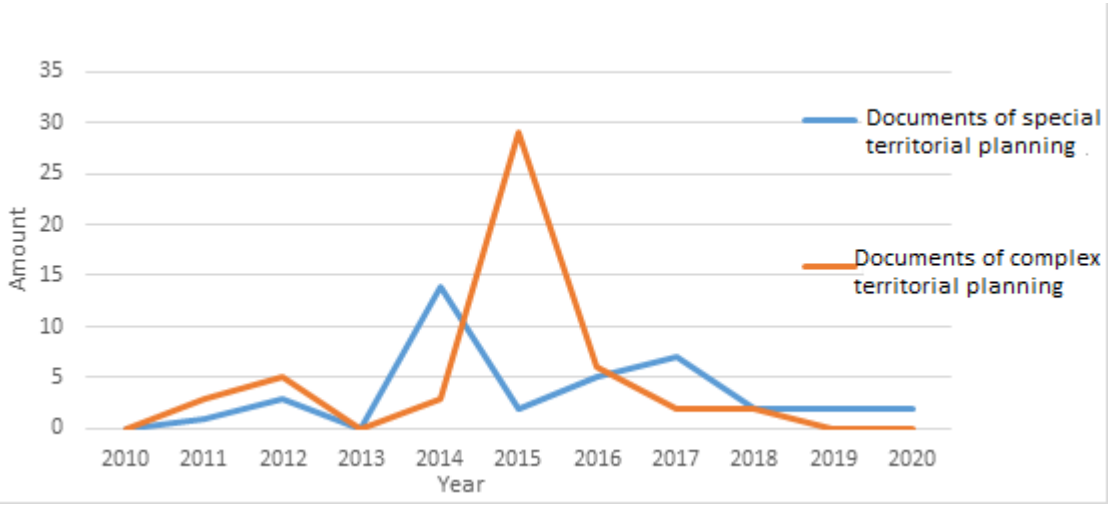


Fig. 1. Volumes of preparation of territorial planning documents in Pagėgiai municipality in 2010 - 2020 (Source: compiled by the authors based on TPDR data)

The data shown in Figure 1 show that the volume of complex territorial planning documents prepared in the municipality in 2015 increased significantly compared to the previous and subsequent years, and the volume of special territorial planning documents was one of the smallest. Taking into account such volumes of preparation of territorial planning documents it can be concluded that 2015 is distinguished by the fact that the territory of the municipality developed the most at that time. Meanwhile, in 2010 and 2013, no special or complex territorial planning documents were prepared in the territory of Pagėgiai municipality, i.e. the development of municipal territories was practically non-existent. In 2014, the need for special territorial planning documents increased the most, when separate activities and their development were planned in the territory of the municipality. During the rest of the period, the volumes of special and complex territorial planning documents in Pagėgiai municipality were very similar and no major differences were observed.
Since the beginning of TPDRIS operation in the territory of Pagėgiai municipality, 7 territorial planning documents have been prepared in the system, of which 3 are complex territorial planning documents, 4 – are special territorial planning documents.
During the research, one of the most characteristic analyzed territorial planning documents prepared in the territory of Pagėgiai municipality, the preparation and administration of which had a negative impact on the development of territories is the level planning of the complex plan "Correction of the detailed plan of the land plot in Pagėgiai, Vilniaus Str. 16A". During the preparation of this territorial planning document, the planning procedures took about six months, due to the discontinuation of the detailed planning process. The reason for the termination of the planning document was that one of the two tasks was incorrectly formulated in the decision made by the order of the Director of Pagėgiai municipality to start preparing the detailed plan adjustment and setting the tasks, which read as follows: "inaccuracy is observed in this formed task, i.e. the use of the land is not specified correctly. Based on the description of the content of the land use method established for the land plot: "Territories of communication and engineering communications service objects" (Dėl pagrindinės ..., 2005). Thus, the institution administering the preparation of the territorial planning document,

in this case, the Pagėgiai municipality administration, during the preparatory phase, following the procedures established in legal acts, introduced the above-mentioned factual error in the wording of the tasks. The occurrence of this error has slowed down the development of the redeveloped area, as the preparation of the planning document has been delayed by repeating the planning process. The preparation of the planning document became inefficient in terms of the administration of the procedures, as the administration of the preparatory phase procedures was repeated, which required additional material and human resources. Also, all this negatively affected the development of the territory, it slowed it down, as the plot of land to be formed was demolished, the construction of a new building, a shopping center and a short-term parking lot, and protective greenery was the needs of the population are also being met, but unfortunately, this has not been the case. The planned development of the territory has slowed down, for the reason previously identified, as a result of which it has had a negative effect on the economic side of the development of the territory, i.e. business entities and their plans to build a shopping center were unbalanced, and the social needs were delayed as well as the installation of protective greenery was delayed for ecology. It can be seen that the whole mentioned situation also negatively affected the implementation of the decisions of the Comprehensive Plan of Pagėgiai City, slowing it down, as the decisions of the Comprehensive Plan also provided for the development of protective greenery and commercial development in the planned territory. That such situations have a negative impact on the development of territories was confirmed by the opinions of experts expressed during the interviews, when the interviewed specialists of the Pagėgiai municipality administration stated that *"the administration of territorial planning processes and procedures has an impact on the development of territories. Decisions or shortcomings identified during the administration may have a direct negative impact on the further development and opportunities of the territory. Only proper administration of territorial planning processes and procedures ensures sustainable development of territories and rational urbanization".*

Another characteristic document of complex, local level territorial planning prepared in the territory of Pagėgiai municipality, by which the administration of preparation processes and procedures had a negative impact on the development of territories, was the "adjustment of the comprehensive plan of Pagėgiai City". In the process of preparation of the planning document, the procedures of the preparation phase lasted the longest (almost one year), which was caused by the delay of the preparation of the planning document, which hindered the preparation process and slowed down the development of the planned territory (Table 5).

Table 5

Duration of the phases of preparation of the territorial planning document "Adjustment of the Comprehensive Plan of Pagėgiai City" (Source: compiled by the authors using TPDRIS data)

Title of the territorial planning document	Duration of the preparatory phase	Duration of the preparatory phase	Duration of preparation for the final phase
"Adjustment of the Comprehensive Plan of Pagėgiai City"	1 month and 27 days	11 months and 1 day	4 months and 6 days

It is important to mention that in the process of preparation of the above-mentioned territorial planning document, the administration of the preparatory phase procedures was quite rational in terms of time, i.e. took up to 2 months, which was influenced by the efficient administration of the planning organizer's procedures. Evaluating the procedures performed by the administrative institutions in the process of preparation of the planning document it was established, that as many as 12 institutions administering the procedures, including the administration of the planning organizer - Pagėgiai municipality, participated in the planning process. The analysis of the procedures performed by the managing authorities showed that the issuance of planning conditions took on average about 6 working days, during which not all managing authorities submitted planning conditions to the prepared document, therefore an automatic response was provided after the deadline for submission of planning conditions generated by the system. For this reason, it can be said that this procedure of preparing a territorial planning document has become partially inefficient, and for the above-mentioned reasons, planning territories have not been fully assessed in the preparation of planning decisions. During the

structured interview, the specialists of Pagėgiai municipality administration stated that *"during the planning, the set goals of the preparation of the planning document are implemented, but in the process of preparation there are shortcomings that prevent the prepared planning document from being as effective as possible - delay of procedures, long preparation time"*. Therefore, based on the situation described above and the results of the interviews, it can be stated that the identified delays in the procedures (in this case, the preparation of planning conditions) have had a negative impact on the development of the planned territory.

The procedure for coordinating the planned solutions in the process of preparing the "Adjustment of the Pagėgiai City Comprehensive Plan" took an average of 8-9 working days. During this procedure, the two managing authorities did not evaluate the planned solutions, and the system automatically reconciled the solutions after the deadline. It is also important to mention that one of the institutions coordinating the solutions - the State Enterprise Lithuanian Road Administration - coordinated the solutions with a remark stating that a road protection zone must be established for the planned territory, which did not exist. However, after inspecting the prepared planning document within 10 working days, the State Territorial Planning and Construction Inspectorate under the Ministry of Environment established that the planning document complied with the established requirements, and administrative procedures were performed without violating the preparation of the planning document.

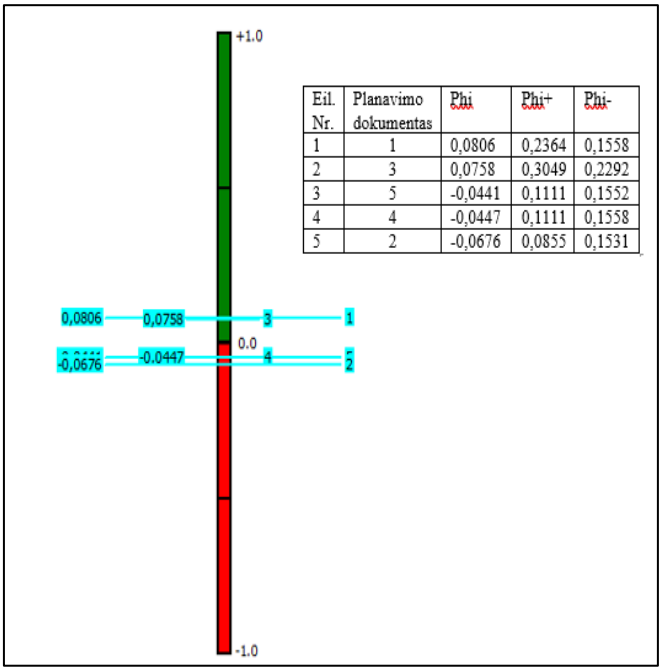
Thus, in the process of preparation of the planning document analyzed above, untimely or completely non-performed procedures had a negative impact on the development of the planned territory. Considering that the goal of the "Adjustment of Pagėgiai City Comprehensive Plan" is focused on the landscape, natural frame, and urban territory adjustment, expanding them, the failure of the institutions administering the procedures negatively affected the urban development, ecological balance, and landscape formation of the planned territory.

The authorities did not fully comply with the planning requirements, which did not substantially assess the existing landscape and its specificity, and therefore the decisions that have been or will be redeveloped in the future do not ensure positive actions for the redevelopment of the site's ecological environment, balance, landscape, its uniqueness or urbanism. During the interview, such assumptions were confirmed by the specialists of Kaunas District Municipality Administration, stating that *"planning processes and procedures have an impact on the further development of territories, only properly performed procedures have a positive impact on planned territories, as to provide planning conditions, to assess the compliance of decisions or requests with the higher level territorial planning document. If it is found that the draft planning document contradicts the higher level territorial planning document or the interests of third parties are violated, the planning conditions may not be issued, the territorial planning document may not be prepared, the process of the planned document would negatively affect the development of the planned territory".*

"Summarizing the detailed analysis of the procedures for the preparation of the above-mentioned territorial planning documents, it can be stated that the most common problems in the process of preparation of the planning document are related to complaints, inadequate legal regulation, problems in coordination and publicity of documents lack expertise, lengthy and complex procedures, lack of smooth inter-institutional cooperation and conflicts of interest. According to the specialists of Kaunas District Municipality Administration, *"the most common problems in the process of preparation of the territorial planning document are related to complaints and / or mandatory requirements. Then the document preparation process is suspended until the received complaints are examined and all interested parties are satisfied. It is often the case that complaints are transferred to the courts, which requires additional resources due to the costly and lengthy court proceedings. "*

To avoid these identified problems and litigation, the interviewed experts suggest providing additional information to stakeholders, familiarizing them with the current situation and seeking and proposing alternative solutions acceptable to all stakeholders, and greater oversight of territorial planning processes.

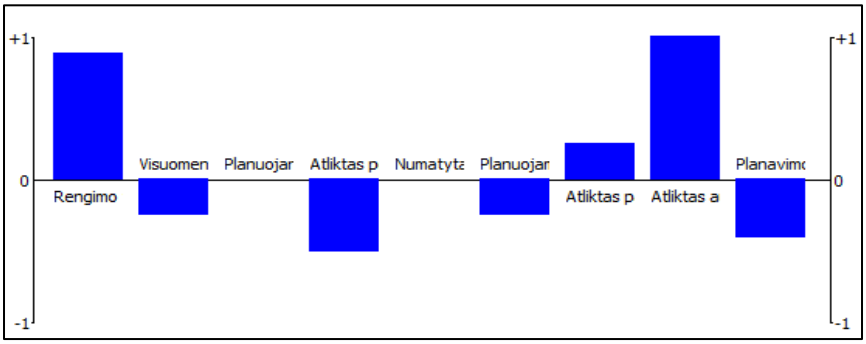
To assess the efficiency of the administration of territorial planning processes according to the established criteria of multi-criteria analysis (Table 1), the most efficient territorial planning document in terms of process and procedure administration has been established in Pagėgiai municipality since 2015 and has a clear positive value for further development of the planned territory. After performing the criteria ranking test, it was determined that in the territory of Pagėgiai municipality the territory planning document of complex planning "Adjustment of the detailed plan of the prepared territory in Vilniaus Str. 16 A, Pagėgiai" with the criteria ranking of 0.0806 was most effectively prepared (Figure 2).



Eil. Nr.	Planavimo dokumentas	Phi	Phi+	Phi-
1	1	0,0806	0,2364	0,1558
2	3	0,0758	0,3049	0,2292
3	5	-0,0441	0,1111	0,1552
4	4	-0,0447	0,1111	0,1558
5	2	-0,0676	0,0855	0,1531

Fig. 2. PROMETHEE ranking test: 1 - adjustment of the detailed plan of the prepared territory in Vilniaus Str. 16 A, Pagėgiai; 2 - adjustment of the Comprehensive Plan of Pagėgiai City; 3 – The Rambynas Regional Park planning scheme (boundary and management plans); 4 - the engineering infrastructure development plan of the special national electricity system synchronization project "Construction of the 330 kilowatt electricity transmission line Kruonis PSHP – Bitėnai"; 5 - engineering infrastructure development plan for the special national electricity system synchronization project "Construction of the 330 kilowatt power transmission line Darbėnai – Bitėnai" (Source: compiled by the authors using PROMETHEE software)

According to the data presented in Figure 2, another territorial planning document was prepared quite effectively - "The Rambynas Regional Park planning scheme (boundaries and management plans)" (ranking indicator - 0.0758), which did not differ significantly in its efficiency from the mentioned before. The complex territorial planning document "Adjustment of the Comprehensive Plan of Pagėgiai City" prepared in the territory of Pagėgiai municipality had the lowest efficiency, the ranking indicator was -0.0676. In detailing the effectiveness of the prepared territorial planning documents, the analysis identified the criteria that positively influenced the process of preparing the planning document. The prepared complex territorial planning document "Adjustment of the detailed plan of the prepared territory in Vilniaus Str. 16 A, Pagėgiai" was positively affected by only three criteria, i.e. those criteria with values greater than 0 (Figure 3).
As can be seen from the presented figure, the efficiency of the planning document was determined by the short preparation time, the lack of re-coordination of the planned solutions, and the lack of automatic approvals. It was also found that the criteria related to the assessment of engineering infrastructure and ecological, economic, and social well-being did not affect the efficiency, while the other remaining criteria hurt the efficiency of the preparation of the assessed planning document.



Rengimo – Prepared
Visuomeninis – Public
Atliktas (?) – carried out, performed drafted... (žiūrint kas)
Numatytas –Foreseen, Planuotas - Planned

Fig. 3. Criteria determining the effectiveness of the territorial planning document "Adjustment of the detailed plan of the prepared territory in Vilniaus Str. 16 A, Pagėgiai" (Source: compiled by the author using PROMETHEE software)

Assessing the criteria of the second most effective territorial planning document "The Rambynas Regional Park planning scheme (boundaries and management plans)" determining its efficiency, it was found that three criteria also had a positive effect on efficiency, but slightly different from the above: public involvement in the planning process, the size of the planned territory and the number of planning areas (Fig. 4).

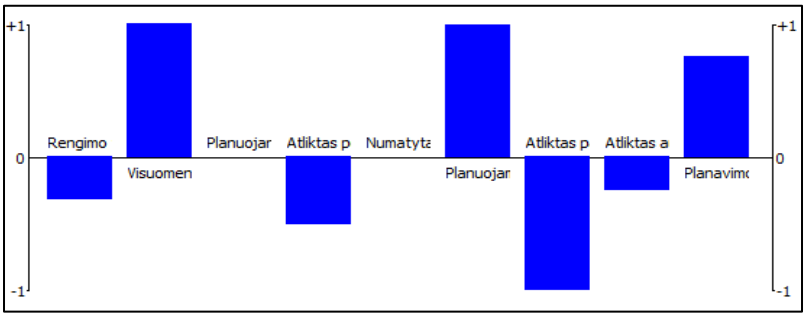


Fig. 4. Criteria determining the effectiveness of the territorial planning document "The Rambynas Regional Park planning scheme (boundaries and management plans)" (Source: compiled by the authors using PROMETHEE software)

When detailing the importance of the criteria, it was found that the re-coordination of the planned solutions had the most negative impact on the planning document, which delayed the planning process and required additional resources, as a result of which, the preparation time was extended. Other criteria that negatively affect the efficiency of the planning document were as follows: no environmental impact assessment was performed and automatic coordination of the planned solutions was performed.
Only two criteria determining the efficiency of the territorial planning document "Adjustment of the Comprehensive Plan of Pagėgiai City" with the worst efficiency were identified: no re-coordination of the formed solutions was performed and many areas are planned in the planning process (Figure 5).

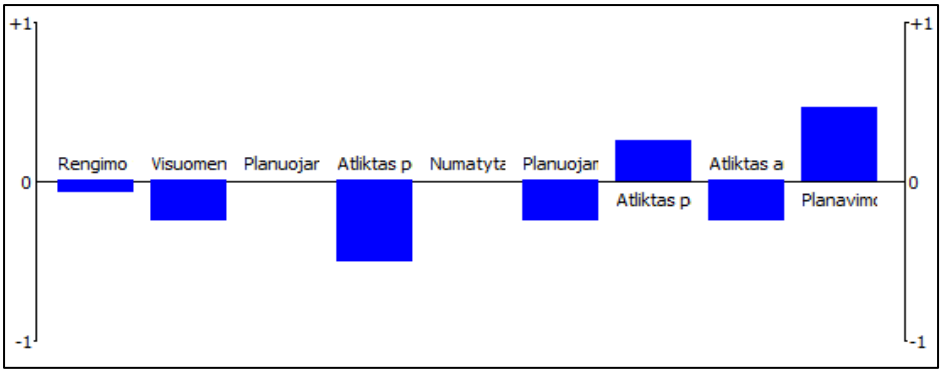


Figure 5. Criteria determining the effectiveness of the territorial planning document "Adjustment of the Comprehensive Plan of Pagėgiai City" (Source: compiled by the author using the PROMETHEE program)

Also, when evaluating the prepared planning document, it was established that two criteria (engineering infrastructure and ecological, economic and social welfare) did not affect the efficiency of the document preparation, the remaining criteria had a negative impact on the efficiency of the planning document. As already mentioned, this planning document was assessed as the least effective of all the analyzed territorial planning documents prepared in Pagėgiai municipality.

Conclusions and proposals

1. After the analysis of complex and special territorial planning documents prepared in Pagėgiai municipality in 2010-2020, it was established that 1 state, 7 municipal and 80 local level territorial planning documents were registered in the territory of Pagėgiai municipality during the analyzed period. In detail, it was found that in 2015, the volume of complex territorial planning documents in Pagėgiai municipality increased significantly compared to the previous and subsequent years, and the volume of preparation of special territorial planning documents was set to be one of the smallest. Meanwhile, in 2010 and 2013 in Pagėgiai municipality, no territorial planning documents were prepared at all. However, in 2014 there was a significant increase in the volume of preparation of special territorial planning documents.
2. The analysis of the administrative processes for the preparation of complex and special territorial planning documents prepared in the territory of Pagėgiai municipality revealed that the planning procedures performed by the administering authorities are partially inefficient, as not all administering authorities harmonize in this case, the planned solutions are not fully assessed and approved automatically. The reason for the inefficient performance of procedures is the lack of human resources in the administering institutions - i.e. there is a shortage of specialists or their inadequate competence. According to experts, non-performed or improperly performed procedures negatively impact the planned territory, slow down its development and do not ensure the possible and most suitable direction for the planned territory. The most common problems in drafting a planning document are the coordination and publication of documents, unjustified redundant requirements from other institutions, lack of specialists and their expertise, lengthy and complex procedures, lack of smooth inter-institutional cooperation, and conflicts of interest.
3. After multi-criteria analysis, it was established that the most effective territorial planning document in the territory of Pagėgiai municipality could be considered the territorial planning document of complex planning "Adjustment of the detailed plan of the prepared territory in Vilniaus Str. 16 A, Pagėgiai" with criteria ranking of 0.0806. In the territory of Pagėgiai municipality, the complex territorial planning document "Adjustment of the Comprehensive Plan of Pagėgiai City" was prepared, and the ranking indicator was -0.0676.
4. To avoid problems in the preparation of territorial planning documents identified during the study, which negatively affect the effectiveness of territorial planning and create preconditions for litigation, it is proposed to provide additional information to stakeholders, seek detailed information, and alternative solutions acceptable to all stakeholders' supervision of the administration of territorial planning processes.

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APPLICATION OF LASER SCANNING IN INTERNAL SURVEYING OF PREMISES AND DEVELOPMENT OF 3D MODEL OF BUILDING

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Abstract
Nowadays, along with the classical and experienced surveying methods, modern technologies are rapidly developing and entering into the economy. Laser scanning has many benefits and uses. Application of this technology results in a point cloud from which it is possible to create three-dimensional models which can represent topographic properties, structure dimensions, and spatial relationships. The aim of the research is to investigate the application of three-dimensional laser scanning in the internal surveying of premises and in the development of the 3D model buildings. The task of the research is to apply the application of laser rangefinder and ultrasonic rangefinder method in the scanning of a building that is characterized by complex architecture, an interior garden, many protrusions, and a special layout of windows and doors. The use of the Stonex X300 laser scanner and Stonex M6 laser rangefinder has been described as well. To achieve the goals and objectives of the research, laser telemetry and ultrasonic telemetry method, method of three-dimensional modeling, as well as analysis of scientific literature, mathematical calculation methods, and analysis of documents and factual materials have been used. As the result of the investigation 3D model of a building consisting of 47 individual point clouds was developed. The main conclusion is that three-dimensional modeling as a computer graphics method for the three-dimensional representation of any object or surface can be used.
Key words: internal surveying of premises; laser scanning; laser telemetry; ultrasonic telemetry; 3D model.

Introduction

Nowadays, along with the classical and experienced surveying methods, the latest technologies are rapidly developing and entering into the economy. Increasingly, surveying companies use GNSS receivers, photogrammetry, and unmanned aerial vehicles, as well as laser scanning systems (LiDAR) in their daily work (The Rising Demand). Laser scanning procedures use laser beams, advanced sensors, Global Positioning Systems (GPS) (An improved solution…2011), Inertial Measurement Units (IMUs), electronic receivers, and photodetectors. Laser scanning has many benefits and uses. The application of this technology results in a point cloud from which it is possible to create three-dimensional models and represent topographic properties, structure dimensions, and spatial relationships (Challenges and opportunities, 2016). Using all these components, the laser scanner can calculate the exact coordinates of surfaces and structures.

Methodology of research and materials

Technical justification of application of three-dimensional laser scanning in internal surveying of premises and development of the 3D model of the building has been approbated on the example of the building of the Faculty of Environment and Civil Engineering of Latvia University of Life Sciences and Technologies in Jelgava. Stonex X300 laser scanner and Stonex M6 laser rangefinder were used to measure the object. To achieve the goals and objectives of research appropriate methods have been used– analysis of scientific literature, mathematical calculation methods, analysis of documents, and factual materials. To give a practical expression of the research results, the author applied laser telemetry and ultrasonic telemetry method, as well as methods of three-dimensional modeling. These advantages of QGIS software were used in research as well as abstract-logical method – to generalize and outline conclusions.

Discussions and results

Advantages of using laser scanning. Laser scanning has several advantages over alternative remote sensing methods, such as photogrammetry. Some reasons for using three-dimensional factor scans for surveying purposes are:

- currently the laser scanning method is the fastest method of earth exploration;

- within the laser scanning process can be collected millions of data points per second, reducing the time and human resources required to perform surveying work;
- laser scanning systems can be mounted on land or air vehicles, as well as mounted on simple measuring stands;
- using laser scanners can be reduced health and safety risks by obtaining information from dangerous or hard-to-reach places, as well as inspecting inaccessible areas (Airborne Laser Scanning), (An approach…2007).

Using LiDAR systems, surveying companies can collect point cloud data even from the most inaccessible areas. As laser scanning is a non-contact measurement method, it can also survey and collect data on protected areas or historic sites. From the detailed three-dimensional models created from the scan data, it is possible to create three-dimensional design (CAD) models. These models can be used to analyze the topographic situation, soil structure, and transport corridors, as well as to simulate construction or urban planning projects.

Spatial scanning is commonly used to scan the interior of buildings and interiors. Today, CAD applications offer advanced rendering and animation capabilities that allow better visualize the design of products (3D laser scanners, 2018; How 3D Laser scanning). One of the biggest disadvantages of laser scanning is that the laser beams cannot pass through some surfaces without creating reflections (Deep structural information…2022). Laser scanning can be divided into three types:

- terrestrial laser scanning;
- mobile laser scanning;
- laser scanning.

Terrestrial laser scanning is suitable for measuring compact objects, such as parking lots, bridges, buildings, shorter road sections, etc. This method ensures an accuracy of a few millimeters.

Because the laser scanner is placed on a moving surface it is important to know its location, therefore laser scanner must be synchronized with the global navigation satellite systems (GNSS) or internal measurement unit (IMU). This method is suitable for large line objects, such as coastlines, street networks, port berths, highways, railways, etc. Mobile laser scanning provides an accuracy of a few centimeters.

When using the ariel laser scanning method, the term LiDAR (light and radar) can often be heard. Scanners are usually attached to unmanned aircraft, helicopter, or airplane. This method provides an accuracy of a few decimetres (Why use a laser). In the practice of surveying work, there is often a desire to obtain data with an accuracy of 1 mm, although an accuracy of 2 cm would be quite sufficient (Mūsdienīgās uzmērīšanas tehnoloģijas, 2016).

Point cloud.

As a result of the application of the laser scanning method, a point cloud is obtained, as a result, processing of which a point cloud model is created, which is attached to the coordinate system (georeferencing). The point cloud is made up of millions of points, and each contains information about the coordinates of its location and the intensity of the signal's reflection (How to create a 3D, 2019). The point cloud can be called a document that contains information about the current state of surveyed area or object. The resulting point cloud can be used for different purposes in different ways:

- as data necessary for design;
- as reference information for the developed model by unmanned aircraft;
- two-dimensional section can be created from the point cloud model and a two-dimensional drawing can be developed based on it;
- various three-dimensional models can be developed from the created model, for example, soil models (solid-models);
- use in change monitoring, compare point clouds obtained at different times and identify changes;
- to compare control measurements with the point cloud information and with the project to detect deviations from the project, etc (Point Cloud (2019); Point Cloud and 3D).

The essence of a point cloud is the simplest form of a three-dimensional model (Figure 1).

Point clouds are created by scanning an object (Georeferenced Point Clouds, 2013). Scanning is completed using a laser scanner or a process called photogrammetry. The point cloud can be used as a visual record of the building, or it can "go through" the building, making accurate dimensional measurements as needed. Point

cloud files are a good way to store and use spatial data in three-dimensional modeling (How to create a 3D, 2019). Point cloud data must be recorded.

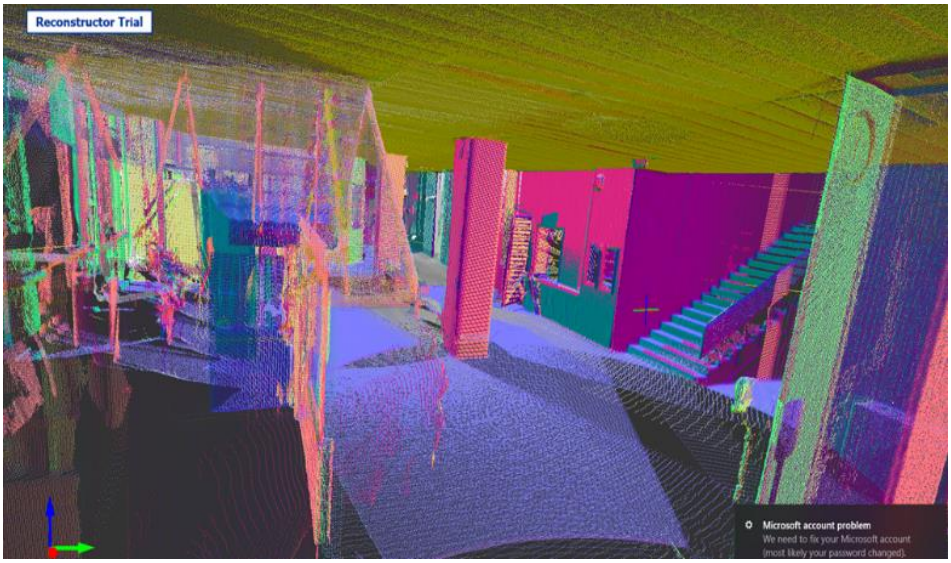


Figure 1. Network of point cloud (source: developed by author)

Only by merging together in an alignment process which is called point cloud registration, is it possible to create a cloud of all the points obtained. To create an accurate three-dimensional model, point cloud registration must be performed with the same accuracy as each point cloud internally. If not done correctly, any created model will be inaccurate and potentially worthless.
In surveying of premises can be applied methods as follows.

- laser rangefinder method;
- ultrasonic telemetry method (Ratkevičs et.al. 2017).

Laser telemetry method. Data processing allows the device to add, subtract, calculate areas, and volumes, and create triangulations. With a laser rangefinder, two sides of the right triangle can be measured, and the third can be calculated using the Pythagorean theorem (Figure 2).

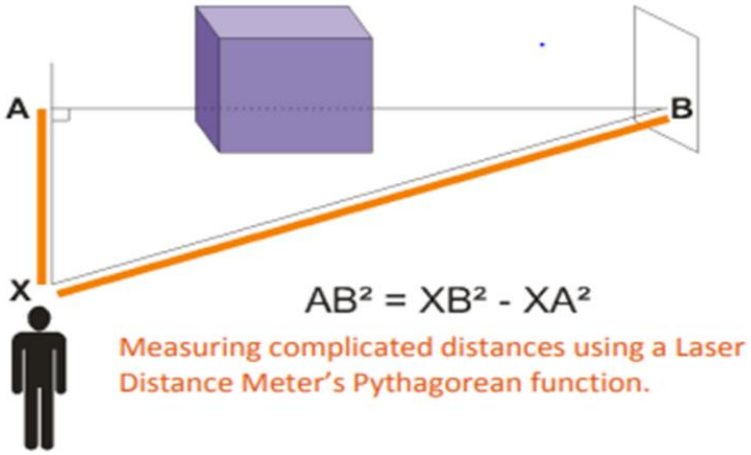


Figure 2. Measurement of complex distance with the laser rangefinder method (source: www.transcat.com)

Ultrasonic telemetry method. An ultrasonic rangefinder is less accurate than a laser rangefinder because the sound is much harder to focus than laser light. If the laser rangefinder provides an accuracy of a few millimeters, then the ultrasonic rangefinder has an accuracy of several centimeters. Ultrasonic telemetry measurements require a fairly large, smooth, flat surface as a target, which is a major limitation in their use. The use of

ultrasonic rangefinders is limited by obstacles in the path of the audible signal if a small target is selected or the signal is not strong enough (Figure 3).

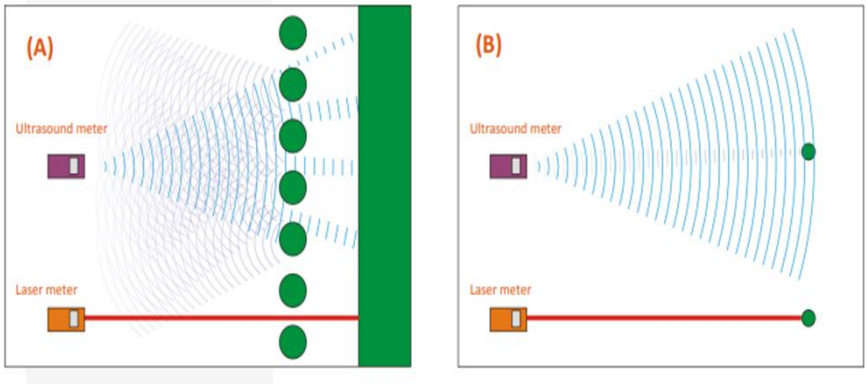


Figure 3. Limitations on the use of ultrasonic rangefinders (source: www.transcat.com)

Laser rangefinder Stonex M6 was used in the study (Figure 4).

Figure 4. Laser rangefinder Stonex M6 used in the study (source: author's photo fixation)

It is easy and convenient to work with this instrument. This tool not only performs primary –point-to-point measurement but also offers many different functions - area and volume calculation, determining the angle at the moment of measurement, etc.

The laser rangefinder method was used to compare data obtained with the laser scanner method. It was concluded that the laser rangefinder can be used as a control measurement method for an indoor three-dimensional model.

Application of laser scanner Stonex X300 in object measurement. The object to be surveyed is characterized by very complex architecture, an inner garden, many extensions, a special arrangement of windows and doors, etc. Work began on an approximate flow chart. The total number of scans was initially 68. Combining them areas where additional scans were needed were detected to cover the object with a point cloud. A mobile smartphone was used to transfer the data. Data were processed using Stonex X300 Manager software, which allows the resulting data archives to be converted to the required format so that they can later be uploaded as separate point clouds to Stonex Reconstructor and data processing begins.

Computer programs. The resulting scan archive needs to be uploaded to the Stonex X300 Manager PC software. It is possible to choose the format of the point cloud, and if necessary, it is possible also to create text files that display X, Y, and Z coordinates, as well as the ability to change image formats, etc. The three-dimensional model was processed using the computer program Stonex Reconstructor, which has many different functions for model processing, variation, and information acquisition (Figure 5).

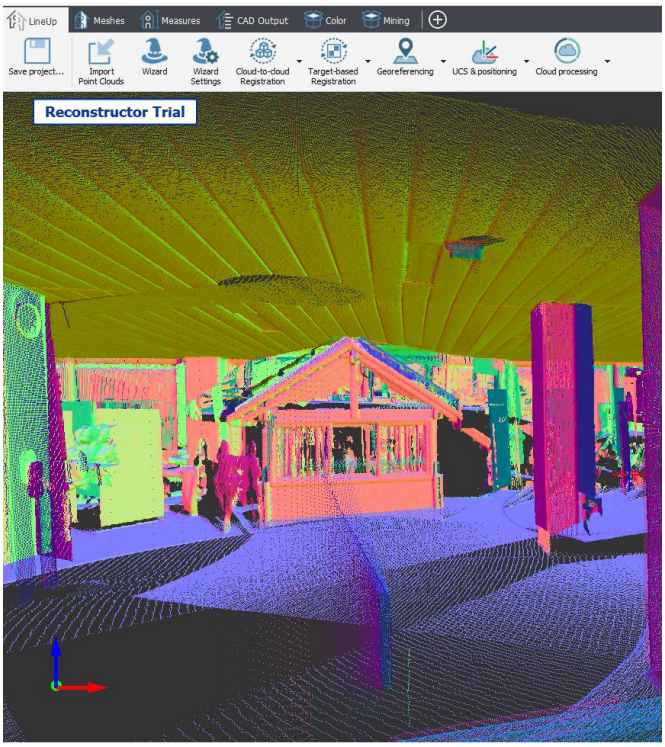


Figure5. Features offered by the Stonex Reconstructor computer program (source: developed by the author)

The initial action was to upload the modified file, i.e., cloud upload for each scan point. There are several ways to connect scan point clouds, but the study used the manual connection method. Two scans were selected that show the same objects in the room. The minimum number of common points must be 3. This function converts the resulting point cloud to a two-dimensional format. It is possible to convert this two-dimensional image of the model into the color format, light black and white or black and white, to make it as easy as possible to identify and find common points. The location of point clouds in the three-dimensional model is shown in Figure 6.

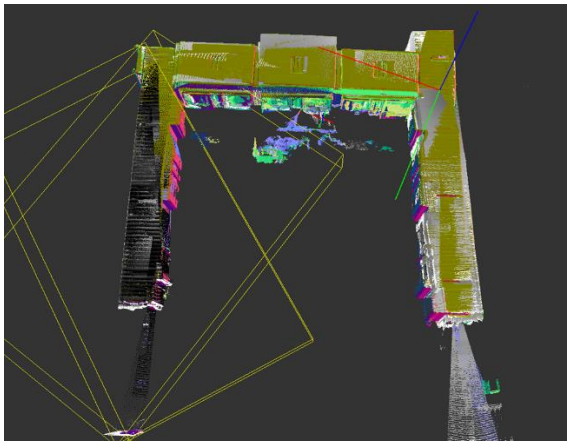
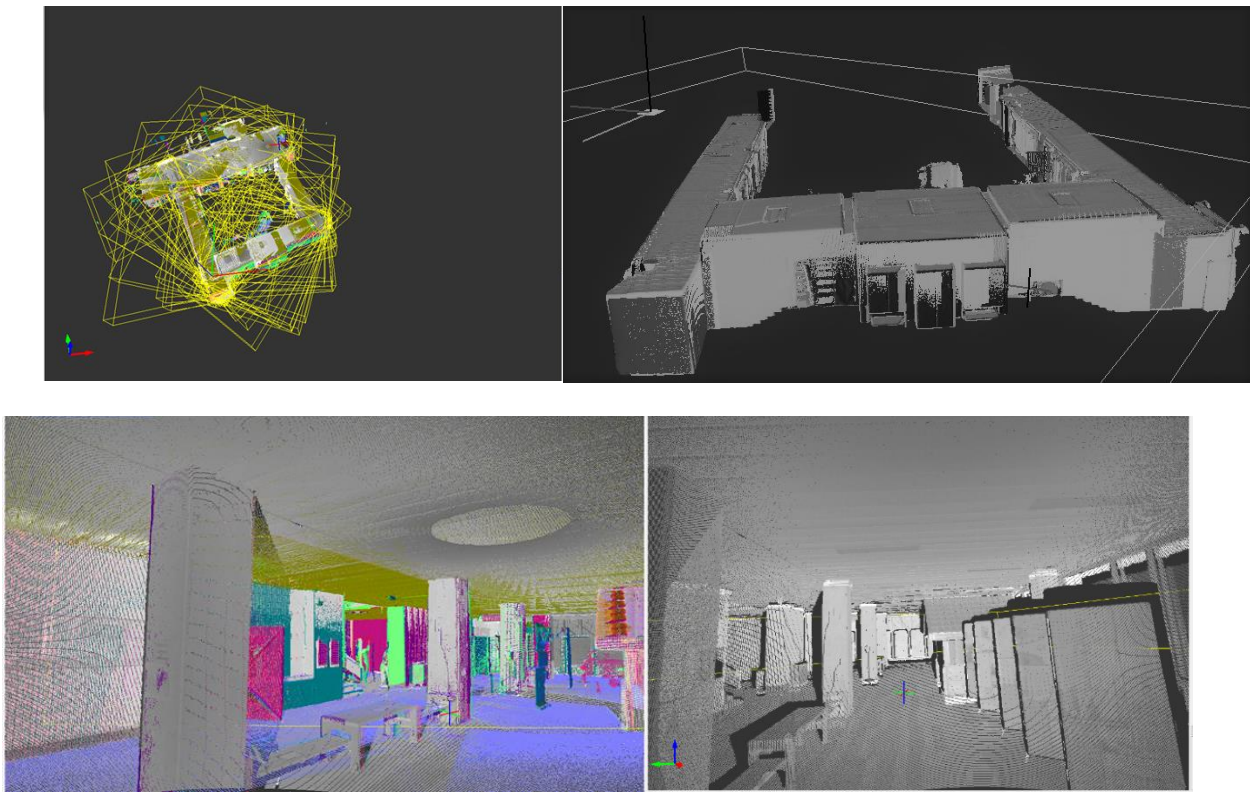


Figure 6. Location of point clouds in the three-dimensional model (source: developed by the author)

Indoor 3D model. Three-dimensional modeling is a computer graphics method for obtaining the three-dimensional surface representation of any object or surface. This three-dimensional model can be generated automatically or created manually by distorting the network or otherwise manipulating slopes. The core of the three-dimensional model is the network that is best described as set of points in space. The three-dimensional

model of an object consists of 47 separate point clouds, which are manually combined to form a common point cloud that forms a three-dimensional model. Because it is difficult to display three-dimensional model in two-dimensional environment, fragments of the model are shown in Figures 7, 8, 9, and 10.



Figures 7, 8, 9, and 10. Fragments of the indoor 3D model (source: developed by the author)

A laser scanning survey has been performed and a 3D model was created in the lobby of the building. Some dimensions were checked with a laser rangefinder. Control measurements showed that the laser scanning product is correct.

Conclusions and proposals

1. The laser scanning survey method is gradually replacing the classical and traditional surveying methods. Classical surveying methods are still relevant if it is necessary to measure the distance or location of certain points or to carry out a survey on a construction site, etc.
2. Today, remote sensing in the surveying industry is entering rapidly and is making a huge contribution to the performance and quality of work.
3. The point cloud obtained by laser scanning can be used in different ways for different purposes.
4. The laser rangefinder is an accurate and fast method of determining distance and requires only one person to work. It is versatile and easy to use.
5. The laser rangefinder can be used as a control measurement method for an indoor three-dimensional model
6. Three-dimensional modeling as a computer graphics method can be used to obtain the representation of the three-dimensional surface of any object or surface.

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WETLAND AREA CHANGE IN KLAIPEDA COUNTY

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Abstract
Wetlands are the most important natural resources, they are the sources of biological, cultural, and economic diversity. The article presents an analysis of the current situation of the wetland area in Klaipeda county.
Analytical, comparative, statistical, and logical analysis methods were used for the investigation.
The aim of the investigation is to carry out the analysis of Klaipeda county's wetland area during the period between the years 2002 and 2022.
In 2022, wetlands occupied 1.21 percent of Klaipeda's county, i.e. 6,337.53 ha. In 2002, the area of wetlands in Klaipeda county was 1.68 percent and occupied 8,748.33 ha. So, in Klaipeda county during the period between the years 2002 and 2022 wetland area decreased by 2,410.80 ha or 27.56 percent. After the analysis of the change in wetland areas in the districts of Klaipeda county, it can be seen that in all municipalities, wetland areas decreased in the period of 2002 – 2022. Many wetlands in Klaipeda county have been exploited and managed for various purposes. Large wetland areas have been drained and reclaimed mainly for agriculture and the establishment of human settlements. Monitoring and inventory of wetlands are important for of conserving and managing wetland resources. An important element of all peatland restoration projects is a programme of monitoring to check results and progress.
The aim of the investigation is to carry out the analysis of the Klaipeda county wetland area during the period between the years 2002 and 2022.
Key words: wetland area, change, climate change.

Introduction
Article relevance. Wetlands are important features in the landscape that provide numerous beneficial services for people, fish, and wildlife. Some of these services, or functions, include protecting and improving water quality, providing fish and wildlife habitats, storing floodwaters, and maintaining surface water flow during dry periods. These valuable functions are the result of the unique natural characteristics of wetlands. Inventory and monitoring of wetlands and adjacent uplands are important for of conserving and managing wetland resources.
Wetlands are ecologically sensitive systems and provide a lot of significant services to the human population (Gokce, 2019). They are complex ecosystems that harbor a large diversity of species. Wetlands are among the most threatened ecosystems on our planet, due to human influences such as conversion and drainage (Verones et. al., 2013).
The authors S. L. Ozesmi and M.E. Bauer state that it is important to inventory and monitor wetlands and their adjacent uplands to conserve and manage wetland resources (Ozesmi, Bauer, 2002).
There is now more and more discussion about the inevitable need to conserve wetlands, as they play a particularly important role: wetlands are highly productive and support a wide variety of ecosystem goods and services (Gallant, 2015); wetland ecosystems provide an optimum natural environment for the sequestration and long-term storage of carbon dioxide (CO_2) from the atmosphere (Mitsch et. al., 2013); help regulate regional climate (Marshall et.al., 2004); wetlands retain water during dry periods, thus keeping the water table high and relatively stable. During periods of flooding, they mitigate flood and trap suspended solids and attached nutrients (Prasad et.al., 2002); they have been found to cleanse polluted waters, protect shorelines, and recharge groundwater aquifers (Mitsch et. al., 2015); at local scales wetlands provide food, fiber, filtering of contaminants, sediment storage, flood control, wildlife habitat, recreation, aesthetics, and other functions (Millenium…, 2005); wetlands provide critical habitat for continental and intercontinental migratory species (Myers, 1983).
These functions are important not only within the wetlands themselves but also to surrounding ecosystems (Greb et. al., 2006).

Even though researchers have paid a great deal of attention to wetland loss and status, the actual extent of wetland loss on a global scale, especially the loss caused directly by human activities, and the actual extent of currently surviving wetlands remains uncertain (Hu et. al., 2017).
Scientists D. Mao, Z. Wang, J. Wu, B. Wu, Y. Zeng, K. Song, K. YI, L. Luo (Mao et. al., 2018) say that humans benefit from multiple ecosystem services of wetlands, but massive wetland loss has occurred worldwide due to rapid urbanization. To assess the problem, it is necessary to quantify the spatial extent of urbanization-induced wetland loss. Also, wetland loss is caused by natural causes and the conversion of wetlands for agricultural and industrial use (Coleman et. al., 2008). Wetland losses and degradation result from drainage for agriculture, filling for urbanization, and road construction (Zedler, 2004).
Wetlands all over the world have been lost or are threatened in spite of various international agreements and national policies, this is caused by: the public nature of many wetlands products and services; user externalities imposed on other stakeholders; and policy intervention failures that are due to a lack of consistency among government policies in different areas (economics, environment, nature protection, physical planning). All three causes are related to information failures, can be linked to the complexity and 'invisibility' of spatial relationships among groundwater, surface water, and wetland vegetation. Integrated wetland research combining social and natural sciences can help in part to solve the information failure to achieve the required consistency across various government policies (Turner et.al., 2000).
So, an integrated wetland research framework suggests that a combination of economic valuation, integrated modelling, stakeholder analysis, and multi-criteria evaluation can provide complementary insights into sustainable and welfare-optimizing wetland management and policy.

Methodology of research and materials
Comparative, analytical, statistical, statistical, and logical analysis methods were used for the investigation.
The article analyses the work of Lithuanian and foreign scientists, published in scientific publications.
The land fund statistics of the Republic of Lithuania (Nacionaline zemes..., 2002-2022), graphically depicted in figures, were used for the fulfillment of the research of the wetland area change in Klaipeda county for the years 2002 - 2022. Fig. 3 was made using the ArcGIS program. This figure shows the percentage of the area occupied by wetlands in the Klaipeda districts.
The article analyzed and assessed the current state of the wetlands in Klaipeda county. The study provides the wetland area change analysis in Klaipeda county and in the districts of the county. The 20 years period, i.e. the period between the years 2002 and 2022, was selected for the determination of the change. Statistics data were systematized and analyzed and the expression of the percentage was calculated during the preparation of the research.
The object of the investigation – is the Klaipeda county wetland area.
The aim of the investigation. To carry out the analysis of the Klaipeda county wetland area during the period between the years 2002 and 2022.
Tasks of the investigation:
1. To describe wetlands in Klaipeda county.
2. To analyze wetland area change in Klaipeda county during the period between the years 2002 and 2022.
3. To examine the wetland area change in the county districts changes.

Discussion and results
The status quo of wetland in Klaipeda county. Wetland habitats serve essential functions in an ecosystem, including acting as water filters, providing flood and erosion control, and furnishing food and homes for fish and wildlife. They do more than sustain plants and animals in the watershed, however. Many wetlands are not wet year-round because water levels change with the seasons.
There are three types of wetlands identified in Klaipeda county (Fig. 1):
1. Low moors are widespread in lakes, river valleys, inter-hill valleys, and on the outskirts of raised bogs.
2. Intermediate moors are widespread in habitats where nutrients are insufficient for fen peat and nutrients and are still too high for raised bog peatlands.
3. Raised bogs. These wetlands are fed only by rainwater and snowmelt, the excess of which flows from the raised surface of the wetland to the edges (lag). Lakelets of various sizes and lake branches can be found in the big raised bogs.

Fig. 1. Distribution of wetland types in Klaipeda county (Lietuvos pelkių, 2022)

In Klaipeda county, there are a lot of different types of wetlands and unevenly distributed within the county. The most important wetlands of Klaipeda county are the Aukstumala wetland and the Svencele wetland.

In the area of Silute district, the *Aukštumala* swamp is flooded - the world's first scientifically described high bog. Occupying a large area of 2,500 hectares, the Aukštumala wetland is truly unique. A natural part of the bog 1,017 ha belongs to preserve, the other part 1,500 ha is a peat bog, exploitation of which has a negative impact on the bog. The whole wetland area belongs to Nemunas Delta Regional Park which is included in the list of Natura 2000. Also, the park and Aukstumala bog is included in the list of Convention on Wetlands of International Importance Especially as Waterfowl Habitat (Ramsar Convention). Aukstumala wetland restoration projects have been implemented:

- Restoration of the raised bog in the Aukštumala Telmological Reserve (2006-2007). During the project, canals and ditches were ponded, and 100 ha of woody vegetation was cleared, thus stopping the degradation of the swamp and water evaporation. Partitions were built in the cut-out places and the water level was raised. The management measure for restoring the hydrological regime of the Aukštumala Telmological Reserve bog covered 1001 ha.
- LIFE project Peat Restore. The LIFE Aukstumala project achieved its main objective to restore the Aukštumala bog to favourable conservation status. They also managed to increase the area of the active raised bog by 15.17 percent. 1,170 dams were installed on small ditches and 15 dams on collective ditches. In addition, 85 km of small ditches and 15 km of larger ones were blocked using peat and plastic pile sheets. This created favourable conservation status in 600 ha of the habitat.

Svencele bog is the largest natural and not yet destroyed coastal raised-bog with neighbouring fens and wet forest in Klaipeda county. Besides, this is the only not yet destroyed coastal raised-bog in Lithuania and among few in the eastern Baltics, which still keeps natural or semi-natural features in the whole area of the bog (Improvement..., 2022). The bog area covers more than 1,200 ha. It was formed during the post-glacial period in the area of the former coastal lagoon. However, the area was affected by drainage in the mid of the 20th century. Although the habitats were not destroyed by human activities like in many other coastal bog complexes of Lithuania, the regular drainage of the bog affected or partly destroyed the

natural habitats and speeded their succession process, thus, losing some of the natural bog features, which are also important for the number of the protected species.
In order to preserve the remaining natural values and restore the damaged hydrological regime of the wetland, the Lithuanian Ornithological Society was implementing a project „Improvement of the conservation status of Svencele“, the aim was to restore the favorable conservation status of Svencele by restoring the hydrological regime and restoring the habitats of rare and endangered birds and plants.
In order to restore the hydrological regime of the Svencele bog damaged by reclamation, to stop the mineralization processes taking place in the bog and the transformation of bog habitats into forest habitats, special forest cuttings to support the biological diversity were designed on an area of 275.4 ha.
Wetland restoration and protection are important to maintain critical wildlife habitat. To achieve this goal, it is important to invest in programs that help implement, support, or coordinate local restoration efforts (United States…, 2022).
Wetland area change in Klaipeda county and districts. Klaipeda county is situated in the western part of Lithuania, in the Pajuris lowland. The county adjoins the Curonian Bay and the Baltic Sea.
In 2022, wetlands occupied 1.21 percent of Klaipeda's county, i.e. 6,337.53 ha. (Fig. 2). Most of them are small and unevenly distributed within the county. In 2002, the area of wetlands in Klaipeda county was 1.68 percent and occupied 8,748.33 ha. So, in Klaipeda county during the period between the years 2002 and 2022 wetland area decreased by 2,410.80 ha or 27.56 percent.

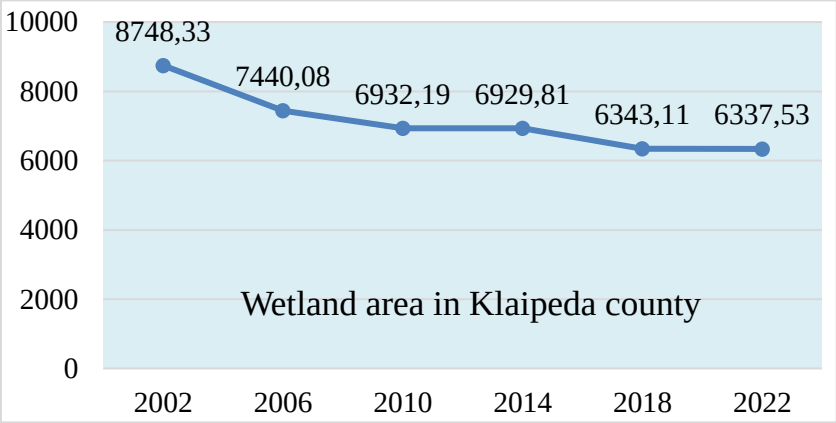


Fig. 2. Wetland area change in Klaipeda county in ha in 2002-2022 (Nacionalinė, 2002-2022) (Consisted by the author of the article)

Klaipeda county includes the districts of Klaipeda, Kretinga, Skuodas, and Silute, the city of Klaipeda as well as the resorts of Neringa and Palanga.
According to the data of 2022, the wetlands in Klaipeda county are situated in Silute district (2.13 percent or 3,590.80 ha) and Klaipeda district (1.48 percent or 1,952.67 ha). In the other five districts, wetlands account for less than 1 percent. The lowest number of wetlands was found in Neringa (0.03 percent or 3.71 ha) and Klaipeda city (0.08 percent or 8.03 ha) (Fig. 3).

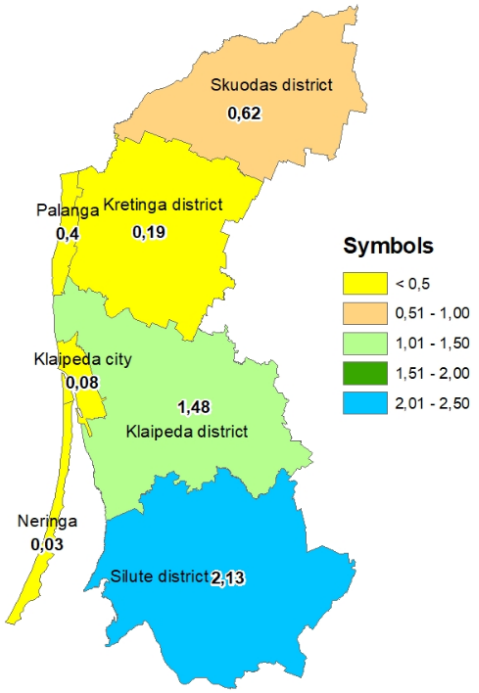
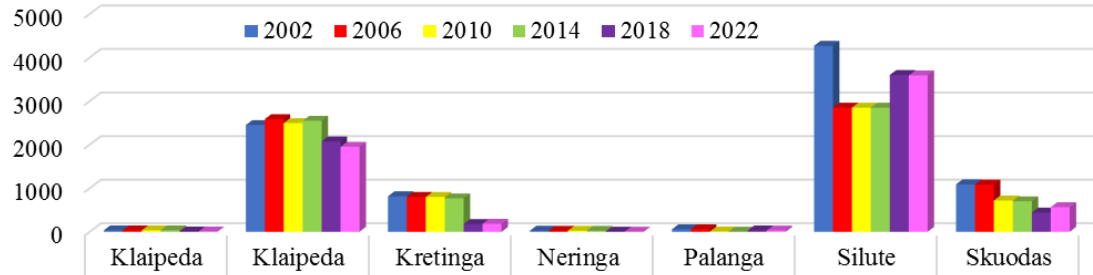


Fig. 3. Wetlands in Klaipeda districts in percent in 2022 (Consisted by the author of the article)

After the analysis of the change of wetland areas in the districts of Klaipeda county, it can be seen that in all municipalities, wetland area decreased in the period of 2002 - 2022 (Fig. 4).



	Klaipeda city	Klaipeda district	Kretinga district	Neringa	Palanga	Silute district	Skuodas district
2002	34,44	2451,38	816,29	26	58,84	4271,18	1090,2
2006	34,44	2586,38	800,51	24,6	58,84	2850,58	1084,73
2010	34,44	2496,29	800,51	24,6	6,83	2850,58	718,94
2014	33,65	2547,98	767,82	24,6	3,69	2850,58	701,49
2018	9,23	2075,51	179,79	3,7	32,35	3600,68	441,85
2022	8,03	1952,67	184,09	3,71	31,33	3590,8	566,9

Fig. 4. Wetlands area change in hectares in districts of Klaipeda in 2002-2022
(Consisted by the author of the article)

Analyzing the data on the change of wetlands as a percentage, it was found that the largest decrease in this land use was in Neringa (85.73 percent), Kretinga district (77,45 percent) and Klaipeda city (76,68 percent). The least change in the area of wetlands was in Silute district (15.93 percent) (Table 1).

Table 1

Wetlands area change in hectares and percent in districts of Klaipeda county in 2002-2021
(Consisted by the author of the article)

District	Wetland area decreased ha	Wetland area decreased percent
Klaipeda city	26,41	76,68
Klaipeda district	498,71	20,34
Kretinga district	632,20	77,45
Neringa	22,29	85,73
Palanga	27,51	46,75
Silute district	680,38	15,93
Skuodas district	523,30	48,00

A small part of the wetlands disappeared due to natural landscape development processes (changes in local moisture balance, formation of river valleys, etc.). Many wetlands are disappearing due to lower groundwater levels during land reclamation and peat exploitation. The condition of many of the surviving wetlands in Klaipeda county is gradually deteriorating due to still operating drainage systems, pollution and climate change, destabilizing the human environment and reducing the prospects for future survival. Wetlands destruction has increased flood and drought damage, nutrient runoff and water pollution, and shoreline erosion, and triggered a decline in wildlife populations and etc. Wetland loss can add stress to remaining wetlands. For example, if fewer wetlands are available to filter pollutants from surface waters, those pollutants could become more concentrated in the remaining wetlands. Wetland loss can also decrease habitat, landscape diversity, and connectivity among aquatic resources. Wetlands are valuable for flood protection, water quality improvement, shoreline erosion control and etc.It is very important to save and restore wetlands because they are particularly vulnerable to a warming climate. Warmer temperatures and the increased use of water for irrigation reduces the supply of water for wetlands, which leads to a higher concentration of pollutants, such as agricultural chemicals, that settle there. Such high concentrations of contaminants can destroy wetlands and every living organism that lives there. Also, changes in temperatures can significantly change the plant and animal life of wetlands. There are many reasons why it is essential to conserve wetlands. They are vital for biodiversity, purifying water, reducing flooding, and fighting against climate change.

Conclusions

1. In 2002, the area of wetlands in Klaipeda county was 1.68 percent and occupied 8,748.33 ha. In 2022, wetlands occupied 1.21 percent of Klaipeda's county, i.e. 6,337.53 ha. During the period between the years, 2002 and 2022 wetland area decreased by 2,410.80 ha or 27.56 percent.
2. According to the data of 2022, the wetlands in Klaipeda county are situated in Silute district (2.13 percent or 3,590.80 ha) and Klaipeda district (1.48 percent or 1,952.67 ha). In the other five districts, wetlands account for less than 1 percent.
3. After the analysis of the change of wetland areas in the districts of Klaipeda county, it can be seen that in all municipalities, wetland areas decreased in the period of 2002 – 2022. it was found that the largest decrease in this land use was in Neringa (85.73 percent), Kretinga district (77,45 percent) and Klaipeda city (76,68 percent). The last change in the area of wetlands was in the Silute district (15.93 percent).

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CONCEPTUAL FUNDAMENTALS OF LAND MANAGEMENT AND LAND MANAGEMENT IN UKRAINE DURING THE PERIOD OF GLOBALIZATION

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Abstract
The application of institutional theory in the development of land management and land surveying to solve land problems in the period of globalization is due to the problems of human security and sustainable development. Institutional theory must justify the use and protection of land not only as a material but also as a public good. Four scientific positions were highlighted, which characterize the international institutionalization of land organization and land planning and related processes: 1) international institutionalization of land organization and land planning as a process of transition to international principles and standards of sustainable land management; 2) international institutionalization of land organization and land planning as a process of creating information on land ownership to ensure comparability of land statistics in the field of land resources and geospatial database and statistical reporting of different countries; 3) international institutionalization of land organization and land planning as a process of unification and harmonization of information systems for land accounting at the international level; 4) international standardization as a process of bringing national norms of territorial and spatial planning of land use development to international level while preserving essential national peculiarities. The relationship between the components of the process of globalization of land management and land surveying is characterized by the impact of globalization on the development of land management and land management. Implementation of institutions and institutes of land management and land surveying is carried out through coordination, redistribution, transactional and capitalization functions for the formation of sustainable (balanced) land use.
Keywords: globalization, land management, land surveying, land use, land resources.

Introduction

All components of economic science are involved in the study of globalization processes. Unlike economists, for land managers, the development and unification of the land management process and land management documentation lack a convincing theoretical basis. The best thing that can be done to scientifically substantiate the expediency of globalization of land management and land surveying is a reference to neoclassical economic theories that profess the expansion of the space of "free capitalist choice." However, as shown by Tretiak A. and other researchers in the works «Scientific hypothesis of interpretation of land management as a socio-economic institution» and «Development of land management system based on the latest institutional and behavioral theory» (Третяк et.al, 2021), it is already yesterday.

The application of institutional theory in the development of land management and land surveying to solve land problems in the period of globalization is due to the security of human life and sustainable development (Третяк et.al, 2021), in particular, processes of climate change, combating desertification and degradation of land and other natural resources.

The main consequences of globalization are the international division of labor, migration across the planet of capital, human and industrial resources, standardization of legislation, economic and technical processes, as well as the convergence of cultures of different countries. According to research by Zos-Kior M. globalization – is the highest stage of social relations based on liberalization and the network principle of the organization, in a single global financial and information space (Зось-Кіор, 2016). So, as noted by Zos-Kior M., and we agree with him, does not have to have the world's largest economy to be considered more or less integrated into the process of globalization - it is important to integrate into global information projects, most of which are on managing limited non-renewable resources, which belong to the land (Зось-Кіор, 2016).

Accordingly, the specific content of global problems is the globality of the studied system or process not so much in quantitative as in qualitative terms. Golovnin M. believes that globalization is giving something a global scale, a global character (Golovnin, 2003).

According to Pankiv Z., it is related to the information transformation of society, not to the scale or economic activity (Паньків, 2008).
The purpose of the article is to study the direction of institutional development of land management and land management in Ukraine in the period of globalization.

Methodology of research and materials

The methodology of studying the processes of globalization of land management and land surveying determines that the subject of the study is the application of institutional theory in the development of land use and land management to solve land problems. For this, the conceptual approach to the relationship between the components of the process of globalization of land management and land surveying is characterized by the impact of globalization on the development of land management and land surveying. Solving land problems in the period of globalization is due to the problems of human security and sustainable development.

Discussions and results

Based on the urgency of the impact of globalization on land management and land use, it is necessary to clarify the essence of globalization for land management and land surveying, including through the action of major current global issues, its impact, and land response to globalization. and the ability of the state to take measures by national law to promote positive and neutralize or mitigate negative consequences of these influences.
The use of land resources is the most important function in the land management system of any country. It determines the prospects of rational nature management, which is a means of implementing the land policy of the state, as well as the coherence of national, regional, and local interests in the rational use of land (Tretiak et.al, 2019).
Due to global climate change processes, and food security issues, any modern economy, including land, transformation must be considered in light of globalization. In this respect, land management and land managers face several key positions that can be called starting points. In Ukraine, which accounts for 0.4% of the world's land, about 5% of the world's mineral resources, including the world's most valuable soils, are extracted (Паньків, 2008), processed, and involved in production. In addition, these resources are used irrationally and extensively. According to Zos-Kior M. (Зось-Кіор, 2016), underutilized agricultural resources against the background of the global food crisis are becoming interesting for international agents. From this point of view, Ukraine has both guaranteed markets and the opportunity to significantly increase its international status, which will be impossible to ignore. At the same time, the high plowing of the territory of Ukraine hurts climate change. Among the main criteria used in world practice to determine the impact of economic activity on land resources and the environment, the most widely used are two: environmental footprint and energy efficiency, as the ratio of GDP to the amount of fuel consumed. The "ecological footprint" criterion is a standardized indicator that reflects the demand of the human population for natural (land) capital, which may even exceed the ecological capacity of the planet or the relevant territory of the country (region) to regenerate this capital. Alternatively, it is the land and water needed by the human population to obtain the renewable resources it consumes and to absorb the relevant waste it produces, using prevailing technologies. In other words, it measures the "amount of nature (land and other natural resources)" we use and compares it to how much "nature" actually has. This unit of measurement can be defined as the ratio between their needs and the amount of available land and other natural resources. In this way you can measure the pressure (impact) on the environment of any person, enterprise, organization, community, country, and population of the planet (fig. 1) (Ecological footprin…, 2021) In 2008, the total biocapacity of the Earth was 12.0 billion ha or 1.8 ha/person, while the ecological footprint was 2.7 ha/person (18.2 billion ha). The largest component of the ecological footprint (55%) is the forest area required for the sequestration of anthropogenic carbon dioxide emissions. In 2014, the Global Footprint Network assessed the ecological impact of humanity on the planet Earth and noted that the demands of mankind were 1.7 times faster than the restored components of the planet's ecosystem (Lin et.al, 2018). The population of the vast majority of developed countries uses more natural capital than is generated in their territory. Thus, the burden on the environment, including land resources in developed countries more than in others. The so-called ecological limits were calculated, which allowed nature to support human activities within the existing way of life. They amounted to 2.2 hectares per capita (Ecological footprin…, 2021).

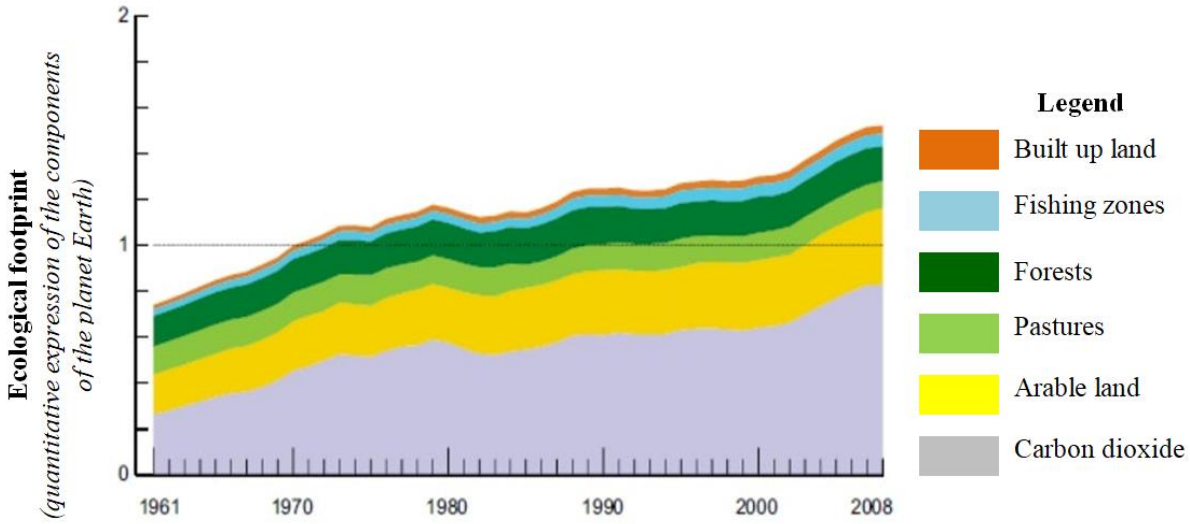

Fig. 1. Global ecological footprint of the components of the planet Earth, 1961-2008 (Рогова, 2015)

The need for institutionalization of land management and land surveying in Ukraine in the period of globalization is beyond doubt. Shortly, scientists and experts' efforts should focus on finding the most appropriate ways to solve this problem. At first glance, its solution is not particularly difficult: it is enough for economists and competent experts to select the best that has accumulated in the theory and practice of land management and surveying of economically developed countries, construct the "best model" and disseminate it. However, such a seemingly obvious solution cannot be implemented in reality, and the reasons for this are as follows

1) features of economic development of different countries;
2) differences in the traditions of land management and land surveying (in many countries, these traditions have developed over several centuries and are quite different from Ukraine);
3) unequal understanding of the subject of land management and land surveying and its methodology;
4) significant features of current regulations;
5) inadequacy of the system of training and staffing of land management personnel;
6) different levels of equipment and use of information base and GIS technologies in land management activities.

Research (Третяк et.al, 2016) shows concern that in the field of institutionalization of land management and land management, the trend of universalization of approaches to land management and land cadastral processes worldwide is taking into account historical, national developments, features of institutions and specifics of certain sectors of the economy (Третяк et.al, 2021).

Research indicates the lack of a common scientific vision of the processes of international institutionalization and sometimes even misinterpretation of their application practices. This scientific problem has two polar positions: the unconditional perception of the international institutionalization of land management and land surveying as a panacea and an inevitable phenomenon, and criticism of the thoughtless implementation of international norms in the national environment. There are four existing scientific positions that characterize the international institutionalization of land management and land surveying and related processes: 1) international institutionalization of land management and land surveying as a process of transition to international principles and standards of sustainable land management (Третяк et.al, 2021) international institutionalization of land management and land surveying as a process of creating information on land ownership to ensure the comparability of land statistics in the field of land resources and geospatial database and statistical reporting of different countries; 3) international institutionalization of land management and land surveying as a process of unification and harmonization of information systems for land accounting at the international level (Третяк et.al, 2021); 4) international standardization as a process of bringing national norms

of territorial and spatial planning of land use development (Третяк et.al, 2021) to international ones while preserving essential national features.

The presence of a large number of relatively conflicting views on the institutionalization of land management and land surveying, especially standardization, harmonization, and unification of land use planning, sustainable land management, and land accounting in the world indicates a lack of common theoretical interpretation of these processes, a vision of its further development and influence on the construction of international and systems of national economic land relations and standards of land use organization in Ukraine. The analysis shows that without fundamental justification, any one-sided perception of this problem, giving preference to certain approaches is unacceptable. However, the quality of preparation of those fundamental normative and organizational documents that will determine the principles of preparation of international rules and standards and their implementation in domestic practice will depend on the scientific position and discussion of scientists on these issues.

In our opinion, rationing and standardization should be considered as a generalizing conceptual approach in this process, at two levels - national and international. The means of implementation (achievement, provision) of standardization are unification and harmonization. The unifying concept is the process of convergence as a convergence of national, regional, and global rules of land management and land surveying.

At the same time, the definitions that characterize the impact of globalization on the development of land management and land surveying are summarized by us as follows:

- rationing and standardization - the establishment of uniform rules (requirements, norms, standards) in the field of sustainable management of land resources and land use, including land management and land surveying;
- unification - elimination of differences between national norms and standards in the field of land protection and land management and land surveying in different countries;
- harmonization - bringing national norms and standards in line with existing international requirements;
- convergence - coordinated convergence of national, regional, and global norms, standards, and systems of sustainable land management, for which land management and land surveying is a fundamental mechanism and methods.

The generalization of existing and proposed approaches to the processes of international standardization of land management and land surveying allows us to conclude that rationing and standardization is a process of establishing harmonized rules for sustainable management of land and land use, land management, and land surveying at the national and international levels. This is ensured by unifying approaches to spatial planning of land use, land management, and land surveying, creating land information, cadastral accounting and evaluation, ie ensuring their comparability, or by harmonization, which is primarily motivated by the rules of land use planning, land management and land surveying and creation of land information to the uniform international requirements (international standards).

The specifics of the functioning of institutions and institutes of land management and land surveying in the formation of a system of sustainable (balanced) land use is that they are designed to regulate environmental and economic land relations entered into by economic entities and reconcile their conflicting interests by greening, the transformation of formal institutions of rational land use that provide real environmental and economic sustainability. The nature of the activities of institutions and institutes of land management and land surveying is determined by the effectiveness of their inherent functions in the implementation of interests at the present stage of development of the land use system (Третяк et.al, 2021) (fig. 2).

The functioning of institutions and institutes of land management and land surveying is well manifested in the analysis of the institutional capacity of the market of land management products and the state. As an institution, the market of land management products reveals coordination, redistribution, transactional and capitalization functions through the actions of objective economic laws of land use organization, distribution, appropriation, operation (consumption), and circulation. The market of land management products cannot effectively solve the threefold task of ensuring the stability of the ecological and economic system due to its spontaneity, so the main burden of forming the institutional environment should be borne by the state. Forming appropriate institutions and institutes, to some extent effectively solves the problems of reconciling the conflicting interests of the subjects at all stages of the process of forming a system of sustainable (balanced) land use.

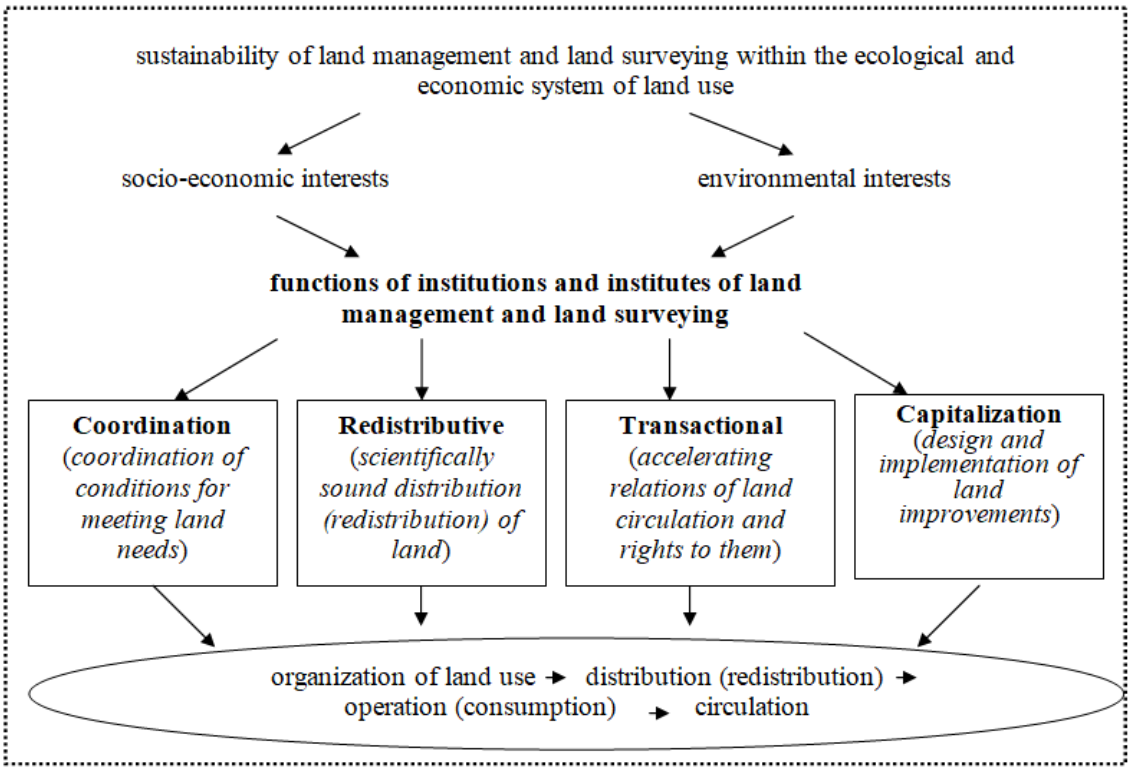

Fig 2. Implementation of the functions of institutions and institutes of land management and land management

The role of effective institutions and institutes of land management and land surveying is to reconcile conflicting interests, the interaction of which is carried out in the framework of dialectical unity and the struggle of opposites manifested at different stages of the development of land relations. This approach to the analysis of institutions and institutes of land management and land surveying reveals a fundamental contradiction, which is the divergence of economic interests in the rapid and expanded consumption of land and other natural resources, even by deteriorating environmental quality and living standards, and environmental interests in land use resources, ensuring real growth in the quality of life by improving the environmental situation and preserving land resources and the environment for future generations.

To identify the nature of environmental and economic interests within the institutional environment of land management and land management, determining their logical systemic structure, it is necessary to analyze the essence of the phenomenon related to the interests of the level of subjectivity - land needs. But this is the subject of another study.

Conclusions and proposals

Thus, we can identify four scientific positions that characterize the international institutionalization of land management and land surveying and related processes:

- the process of transition to international principles and standards of sustainable land management;
- the process of creating information on land ownership to ensure the comparability of land statistics in the field of land resources and geospatial database and statistical reporting of different countries;
- the process of unification and harmonization of information systems for land accounting at the international level;
- the process of bringing national norms of territorial and spatial planning of land use development to international ones while preserving essential national peculiarities.

he conceptual approach of the relationship between the components of the process of globalization of land management and land surveying is characterized by the impact of globalization on the development of land management and land surveying. Implementation of institutions and institutes of land management and land surveying is carried out through coordination, redistribution, transactional and capitalization functions for the formation of sustainable land use, distribution, appropriation, operation and circulation.

Prospects for further exploration are to study the nature of environmental and economic interests in the institutional environment of land management and land surveying, determine their logical systemic structure, and analysis of the essence of the phenomenon related to the interests of the level of subjectivity - land needs.

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