ALEKSANDRAS STULGINSKIS UNIVERSITY (Lithuania)
LATVIA UNIVERSITY OF AGRICULTURE

Aleksandras Stulginskis University

PROVENTUS PRO PATRIA

BALTIC SURVEYING

INTERNATIONAL SCIENTIFIC JOURNAL

2016

Volume 4

ISSN 2255 – 999X (online)

ISSN 2255 – 999X (online)

ALEKSANDRAS STULGINSKIS UNIVERSITY (Lithuania)
LATVIA UNIVERSITY OF AGRICULTURE

BALTIC SURVEYING

INTERNATIONAL SCIENTIFIC JOURNAL

2016 / 1

Published since 2014

Technical Editor: Aurelija Tarasevičienė, Bac.soc.sc. (Lithuania)
The English Language Editor: Lina Abraitienė, PhD candidate (Lithuania)

Editorial board:

Independent reviewers:

1. **Abalikštiene Edita**, Dr., docent (Kaunas Forestry and Environmental Engineering University of Applied Sciences)
2. **Aleknavičius Audrius**, Doctor of technology science, professor (Aleksandras Stulginskis University, Lithuania)
3. **Aleknavičius Marius**, Doctor of technology science, assocciate professor (Aleksandras Stulginskis University, Lithuania)
4. **Baumane Vivita,** Dr.oec., associate professor (Latvia University of Agriculture)
5. **Chyzh Dzmitry**, Candidate of economic science, docent (Belarussian State University)
6. **Furdychko O**., Doctor of Economic Science, professor (Institute of Agroecology and Environmental Management of National Academy of Agrarian Sciences of Ukraine)
7. **Grybauskiene Vilda,** Doctor of technology science, lector (Aleksandras Stulginskis university, Lithuania)
8. **Gurskiene Virginija,** Doctor of technology science, docent (Aleksandras Stulginskis University, Lithuania)
9. **Heldak Maria**, Dr.hab.ing, professor (Wroclaw University of Environmental and Life Sciences)
10. **Horjan Oleg,** Doctor of economic science, docent (State Agrarian University of Moldova)
11. **Jankava Anda**, Dr.oec., professor (Latvia University of Agriculture)
12. **Jurgenson Harli**, PhD, docent (Estonian University of Life Sciences)
13. **Kosinskij Vladimir,** Doctor of economic science, professor (State University of Land Use Planning, Russia)
14. **Kriaučiūnaitė-Neklejonovienė Vilma**, Doctor of technology science, docent (Aleksandras Stulginskis university, Lithuania)
15. **Liba Natalia,** PhD**,** assoc.prof. (Estonian University of Life Sciences)
16. **Liibusk Aive**, PhD, lecturer (Estonian University of Life Sciences)
17. **Marian Madalina,** PhD, lecturer **(**University of Pitesti, Romania)
18. **Parsova Velta**, Dr.oec., professor (Latvia University of Agriculture)
19. **Perovich Lev**, Doctor of technical science, profesor (University of Life Sciences of Lublin, Poland)
20. **Pomelov Aleksandr**, Candidate of economic science, docent (Institute "Belgiprozem", Belarus)
21. **Punys Petras**, Doctor of technology science, professor (Aleksandras Stulginskis University, Lithuania)
22. **Puzienė Rūta**, Doctor of technology science, docent (Aleksandras Stulginskis university, Lithuania)
23. **Rekus Donatas**, Doctor of technology science, docent (Aleksandras Stulginskis University, Lithuania)
24. **Valčiukienė Jolanta**, Doctor of technology science, docent (Aleksandras Stulginskis university, Lithuania)
25. **Vesperis Vladislavs**, Dr.oec., docent (Latvia University of Agriculture)

FOREWORD

BALTIC SURVEYING (ISSN 2255 – 999X) is international scientific journal. The periodicity of the journal is 1 or 2 volume per year.

Universities from Latvia and Lithuania joined their efforts to publish international scientific journal BALTIC SURVEYING. It is jointly issued by:

- Department of Land Management and Geodesy of Latvia University of Agriculture
- Institute of Land Use Planning and Geomatics of Aleksandras Stulginskis University (Lithuania).

In the 4rd volume of the journal are included 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 Easten Europe and elsewhere. The journal is the first one in the Baltic countries dealing with the issues mentioned above.

This scientific journal contains peer reviewed papers. For academic quality each paper has been reviewed by two independent anonymous academic reviewers having Doctors of science degree. Editorial Board has made the final decision on the acceptance for publication. Each author is responsible for high quality and correct information of his/ her article.

We believe that in the future scientists from other foreign countries will become authors of research articles, and the topics of articles will range widely.

We believe that journal will disseminate the latest scientific findings, theoretical and experimental research and will be extremely useful for young scientists

Scientific journal BALTIC SURVEYING already is indexed in Agris database. Published scientific papers will be submitted to CAB Abstracts and EBSCO Academic Search Complete databases. The data bases select the articles from the proceedings for including them in their data bases after individual qualitative and thematic examination.

Volume 4 is compiled by Institute of Land Use Planning and Geomatics of Aleksandras Stulginskis University (Lithuania). Address: Universiteto g. 10, LT-53361, Akademija, Kauno raj., Lithuania

Editorial board

CONTENT

EUROPEAN VERTICAL REFERENCE SYSTEM TESTING USING GNSS MEASUREMENTS IN LATVIA

Armands Celms, Ilona Reķe, Jānis Rusiņš
Latvia University of Agriculture, Faculty of Environment and Civil Engineering,
Department of Land Manegement and Geodesy

Abstract
Since 1st December 2014, Latvia as a national height system is determined by implementing the European Vertical Reference System in Latvia – Latvian Normal Height System 2000,5 (LHS-2000,5). For height calculations, a transformation formula exists for acquiring the theoretical value of the height difference between LHS-2000,5 and Baltic Normal Height System 1977 (BHS-1977) in any place in Latvia. The performed practical GNSS measurements and the obtained mathematical processing data lead to the possibility of having ellipsoidal heights of a point. However, by using the geoid model concerning mathematical correlations it is possible to achieve the normal height of a point, in this case point height that corresponds with LHS-2000,5. As a result, it is possible to compare the differences between the theoretical and practical values in BHS-1977 and LHS-2000,5. The study provides an analysis of the differences between the theoretical and practical measurements concerning BHS-1977 and LHS-2000,5 and its possible causes.
This study aims at determining differences between BHS-1977 and LHS-2000,5, obtained by completing theoretical and practical measurements. To achieve the goal the following tasks are set: 1) to perform global positioning measurements in the national I class levelling network in order to obtain practical values of point height difference in two height systems; 2) to obtain point height difference theoretical values using the height transformation formula; 3) to compare the obtained practical and theoretical values.
Key words: Latvian Normal Height System, GNSS, elevation.

Introduction

Starting from 1st December 2014, the Cabinet of Ministers and state laws have established the European Vertical Reference System realization in Latvia as the national height system – Latvian Normal Height System 2000,5 (LHS-2000,5) (Celms, Bimane, Reķe, 2014). Prior to that, the Baltic Normal Height System 1977 (BHS-1977) was used as the national height system (Celms, Helfrica, Kronbergs, 2007).
Nowadays the Global Navigation Satellite System (GNSS) offers ever more advantages. So to test LHS-2000,5 authors used GNSS measurements of 12 first class levelling points in the entire territory of Latvia and compared the obtained data with the data calculated using transformation formula for the height difference calculation between two height systems (Latvian quasigeoid model, 2015). The global positioning for obtaining practical values was selected because of its simplicity – using global positioning and calculating ellipsoidal coordinates makes it possible to observe the height difference control concerning the height system datum point and regional main geodetic points (Lazdans *et al.*, 2009). On these points, where it is not possible to perform direct GNSS observations, it is still necessary to carry out precise levelling works (Celms *et al.*, 2013).
The levelling network is an element that forms the national height system. Levelling networks ensure the realization of various functions in the national economy (Celms, Kronbergs, Cintina, 2013).
Precise GNSS measuring requires having a precise quasigeoid model. As of 1st December 2014, Latvian specialists have developed a new quasigeoid model LV'14 with the accuracy of 4 cm.
The study aims at determining differences between BHS-1977 and LHS-2000,5, obtained by completing theoretical and practical measurements. To achieve the goal the following tasks are set: 1) to perform global positioning measurements in the national I class levelling network in order to obtain practical values of point height difference in two height systems; 2) to obtain point height difference theoretical values using the height transformation formula; 3) to compare the obtained practical and theoretical values.

Methodology of research and materials

First of all, in order to perform GNSS measurements to obtain practical values of point height difference in two height systems, BHS-1977 and LHS-2000,5, the national geodetic network point inspection was carried out. Certain points were selected and then visited onsite to detect the horizon above point and the possibility to use GNSS methods to determine the height of each point (the point location conformity to point abris). Also, real time global positioning measurements were completed to detect the location of satellites located above the point. After the inspection, twelve I class levelling

network points were selected as appropriate geodetic points for GNSS measurements – ground marks 1415, 1001, 37, 1155, 1537, 1636, 1727, 8248 and fundamental marks 1484, 0608, 3389 and 1463 (Fig.1)

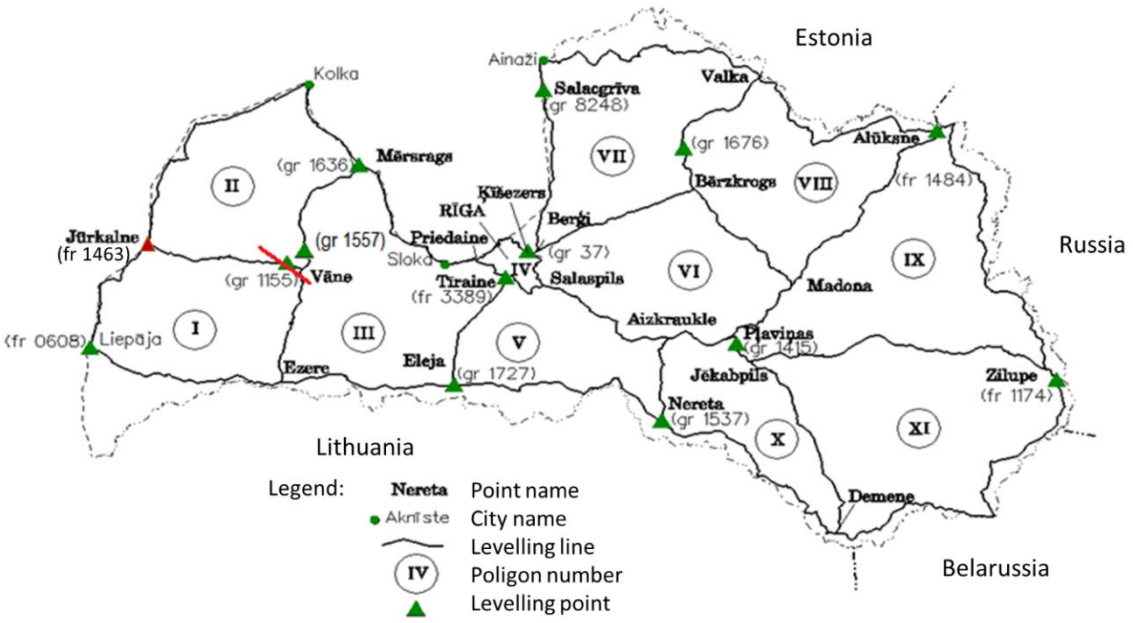


Fig.1. Performed GNSS measurements in I class levelling network

Three measurement sessions were completed, on 14th December 2012, 22th November 2013, and 27th November 2014 in the entire territory of Latvia, simultaneously using global positioning in the post-processing mode. The measurement took four hours, from about 10 AM to 14 PM in the Latvia Positioning System Base Station (LatPOS) network. LatPos is a continuously operating GNSS network of Latvia (Celms, Ratkevics, Rusins, 2014). At each point a GNSS receiver (Leica, Trimble, Topcon or GeoMax receiver) was installed that collected the GNSS data for four hours.

In order to ensure precise data processing and adjustment after measuring, data from three nearest LatPOS base stations from LatPOS home page choosing respective base stations was collected. The data from GNSS receivers and LatPOS stations was used for data adjustment and point height determination (Reiniks, Lazdans, Ratkus, 2010). Fig. 2. shows the location of the measured points and the LatPOS base stations.

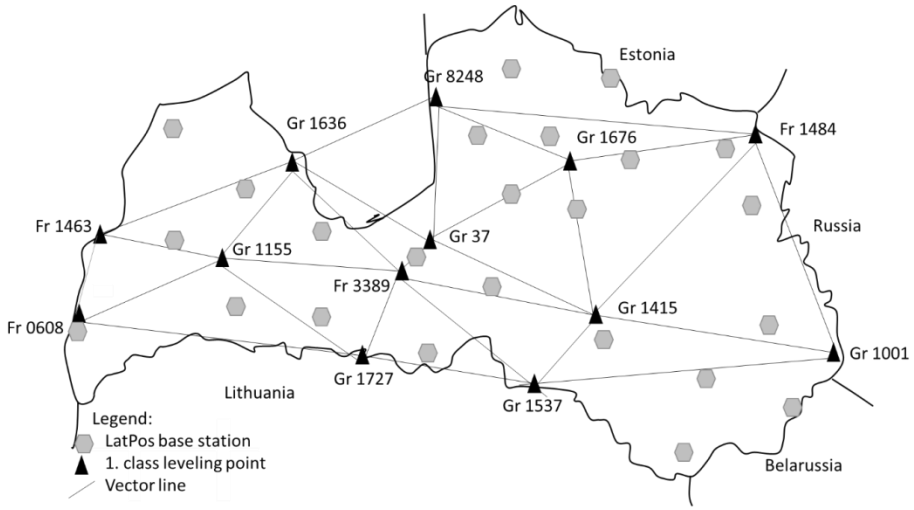


Fig. 2. Vector lines between the measured I class leveling network points and the locations of the LatPOS base stations

Setting relevant parameters during data processing the point height can be adjusted in both height systems, i.e. BHS-1977 and LHS-2000,5. The difference between both height systems is the practical value – the height difference, calculated using the GNSS method (Celms, Eglaja, & Ratkevics, 2015).

For more precise results, the average value of point height from all three measuring sessions was calculated.

Theoretical values of point height difference – the height difference between BHS-1977 and LHS-2000,5 – has been determined by the Cabinet Regulation No. 879 (adopted on 15 November 2011) 'Regulations Regarding the Geodetic Reference System and the Topographic Map System'. The regulation defines the height transformation formula from BHS 1977 to LHS-2000,5:

$$H_{(II)} = H_{(I)} + a_1 + a_2 \cdot M_0 \cdot (LAT\text{-}LAT_0) + a_3 \cdot N_0 \cdot (LON\text{-}LON_0) \cdot \cos(LAT) \quad (1)$$

Where $H_{(I)}$ denotes height in BHS-1977 [m];

$H_{(II)}$ denotes height in LHS-2000,5 [m];

M_o denotes radius of curvature in the meridian of GRS80 [m] in P_o, 63840416.7 m;

N_o denotes radius of curvature perpendicular to the meridian of GRS80 [m] in P_o, 6393195.1 m;

LAT denotes latitude in ETRS89 [radian];

LON denotes longitude in ETRS89 [radian];

$P_o(LAT_o,LON_o)$ denotes reference point of the transformation, LAT_o = 56°58' = 0.994255897 radian; LON_o = 24°53'= 0.434296096 radian;

a_1 denotes vertical translation 1.49392900367864 E-0001 m;

a_2 denotes slope in the direction of the meridian 7.99066182789555 E-0008 m;

a_3 denotes slope in the direction perpendicular to the meridian 9.48289473646151 E-0008 m.

For reasons unknown, the regulation defines two parameters – slope in the direction of the meridian a_2 and slope in the direction perpendicular to the meridian a_3 – in metres, which is probably a mistake, because parameters a_2 and a_3 can be determined only in radians or seconds. In order to complete the height difference calculations, the authors of the study adopted the values of both these parameters in radians (Celms, Reke, Ratkevics, 2015).

Having calculated the results using the transformation formula, a height difference between BHS-1977 and LHS-2000,5 in the entire territory of Latvia results as not a constant value, but differs from 125 mm at the south-east part of the country to 173 mm at the north-west part of the country (Fig.3.) and depends on the point location in the territory (coordinates). The amplitude between south-east and the north-west part of the country is 48 mm.

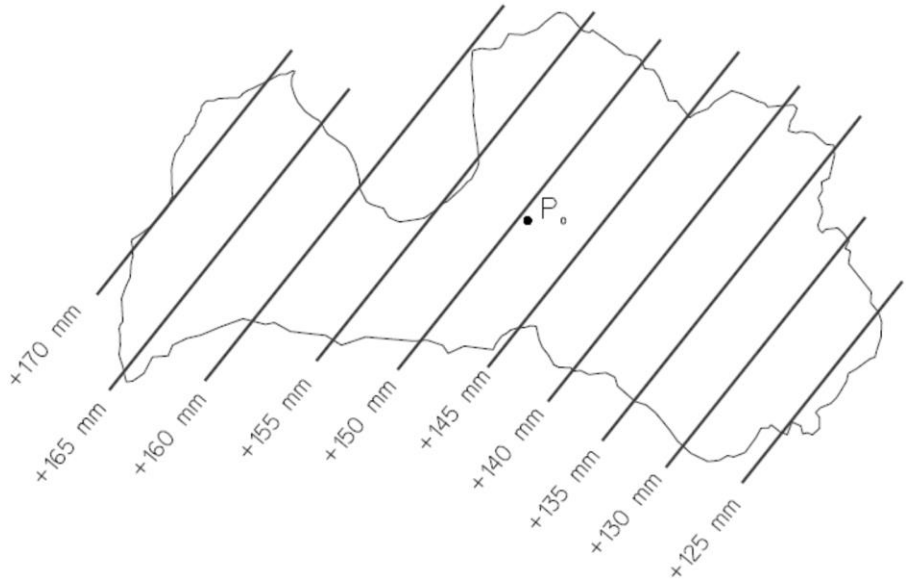


Fig. 3. The height difference between BHS 1977 and LHS-2000,5

Using the transformation formula the authors of this study calculated the point height difference between both height systems of the same I class levelling network points measured with GNSS. $H_{(I)}$ was used as point height in BHS 1977 with the GNSS measured point height in BHS-1977 average value for all three sessions.

Discussions and results

The adjusted results of GNSS measurements from all three sessions are listed in Table 1. The measured data can be adjusted both for BHS-1977, using the geoid model LV 98, and for LHS-2000,5, using new geoid model LV'14. The next column shows the difference between both values. For more precise data, the average value of point height difference between BHS-1977 and LHS-2000,5 has been calculated, i.e. the practical values of point height difference in two height systems.

Table 1

Point heights and height difference between BHS-1977 and EVRF2007 of the measured points

Session year	Point	Measured height in BHS-1977, m	Measured height in EVRF2007, m	Height difference between BHS-1977 and EVRF2007, m	Point average height difference, m
2012	1001	138.649	138.820	+ 0.171	+ 0.175
2013		138.662	138.846	+ 0.184	
2014		138.677	138.848	+ 0.171	
2012	1155	94.520	94.731	+ 0.211	+ 0.175
2013		82.026	82.188	+ 0.162	
2014		82.016	82.169	+ 0.153	
2012	1415	76.842	76.900	+ 0.058	+ 0.058
2013		76.853	76.911	+ 0.058	
2014		76.861	76.918	+ 0.057	
2012	1484	156.812	156.946	+ 0.134	+ 0.101
2013		156.739	156.755	+ 0.016	
2014		156.731	156.783	+ 0.152	
2012	1537	80.589	80.661	+ 0.072	+ 0.075
2013		80.458	80.538	+ 0.080	
2014		80.381	80.454	+ 0.073	
2012	1636	6.857	7.124	+ 0.267	+ 0.268
2013		6.852	7.120	+ 0.268	
2014		-	-	-	
2012	1676	58.536	58.650	+ 0.114	+ 0.111
2013		58.531	58.633	+ 0.102	
2014		58.509	58.625	+ 0.116	
2012	1727	32.393	32.575	+ 0.182	+ 0.182
2013		32.381	32.568	+ 0.187	
2014		32.387	32.565	+ 0.178	
2012	37	7.383	7.533	+ 0.150	+ 0.151
2013		7.357	7.509	+ 0.152	
2014		-	-	-	
2012	8248	4.723	4.829	+ 0.106	+ 0.161
2013		4.722	4.935	+ 0.213	
2014		4.694	4.858	+ 0.164	
2012	0608	-	-	-	+ 0.112
2013		5.727	5.838	+ 0.111	
2014		5.641	5.754	+ 0.113	
2012	3389	-	-	-	+ 0.126
2013		12.474	12.633	+ 0.159	
2014		12.394	12.488	+ 0.094	
2012	1463	-	-	-	+ 0.151
2013		-	-	-	
2014		13.476	13.627	+ 0.151	

Unfortunately, in some cases it was impossible to perform GNSS measurements of the point in all three sessions. Some points had changed their locations due to road construction works and in some cases there were problems concerning data adjustment.

Point No.1636 has greatest average height difference, 0.268 m, while point No. 1415 has the smallest average height difference, 0.058 m. However, based on further results these values are not comparable to each other, but they will be compared to the theoretical values of point height difference in two height systems.

The authors of the study calculated the theoretical values of point height difference in two height systems using the transformation formula and using $H_{(I)}$ as the point height in BHS-1977 with GNSS measured point height in BHS-1977 average value for all three sessions. The results, i.e. the height difference in the entire territory of Latvia and the height difference of each measured point are shown in Fig. 4. As seen in the figure, none of the measured point height differences coincide with the height differences resulting from the transformation formula, except point No.37 which is quite close to the calculated height difference.

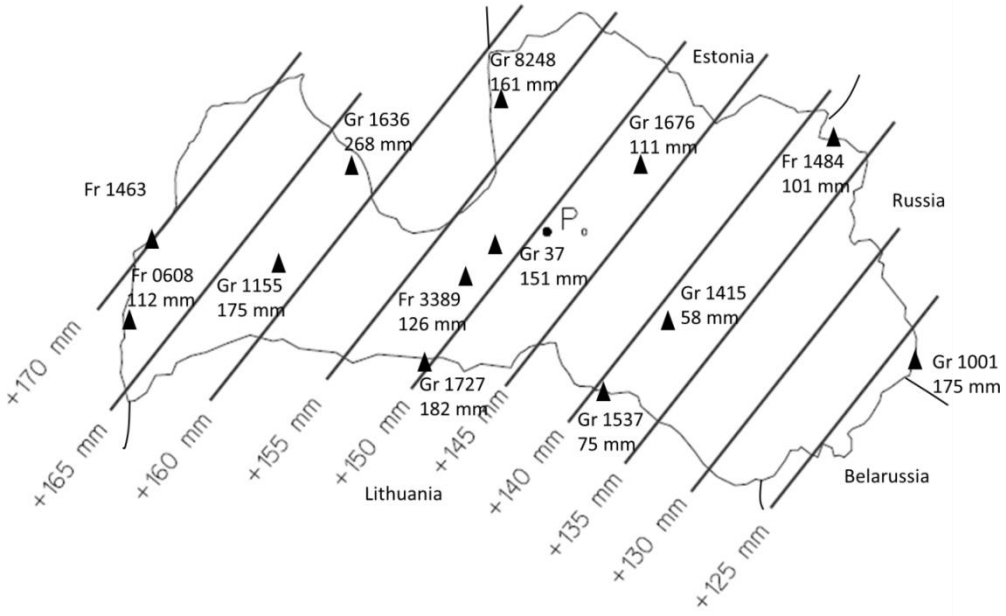


Fig. 4. Height difference between BHS-1977 and LHS-2000,5

The exact values of point height difference between BHS-1977 and LHS-2000,5 using GNSS measurements (practical values) and transformation formula (theoretical values) is shown in Table 2.

Table 2

Calculated point height difference between BHS-1977 and LHS-2000,5

Point	Calculated point height difference between BHS-1977 and LHS-2000,5 using GNSS measurements, m	Calculated point height difference between BHS-1977 and LHS-2000,5 using the transformation formula, m	Difference
1001	0.175	0.125	0.050
1155	0.175	0.163	0.012
1415	0.058	0.141	-0.083
1484	0.101	0.140	-0.039
1537	0.075	0.141	-0.066
1636	0.268	0.164	0.104
1676	0.111	0.150	-0.040
1727	0.182	0.151	0.031
37	0.151	0.144	0.007
8248	0.161	0.159	0.002
608	0.112	0.168	-0.056
3389	0.126	0.153	-0.027

The right column of Table 2 shows the difference between practical and theoretical values. The difference varies from -0.066 to 0.104 m, constituting a 17 cm amplitude. Point No.8248 has the smallest difference between practical and theoretical values: the height difference calculated by using GNSS measurements differs from the height difference calculated by using the transformation formula by just about 0.002 m. Point No.37 has the next closest difference, 0.007 m. Points No. 1415; 1484; 1537; 1676; 608 and 3389 have negative height differences. The negative aspect of this is that such a difference also displays negative values because the transformation formula shows the homogeneity of height difference. The most likely explanation is that the transformation formula does not work

correctly or that the developed geoid model is not sufficiently precise. Consequently, this study requires further research.

Conclusions and proposals

GNSS measured data can be adjusted for both BHS-1977 and LHS-2000,5 by using different geoid models – LV 98 and LV'14 – thus allowing for calculating the difference in point heights between BHS-1977 and in LHS-2000,5. The comparison of the calculated height difference of 12 I class levelling points in the entire territory of Latvia to the point height difference calculated using the transformation formula shows a difference of 17 cm in amplitude which indicates that there are issues with the transformation formula or the need to improve the geoid model.

Regarding the significance of the geoid model to the precision of the geodetic result data, it is preferred to perform GNSS measurements of I class levelling networks in Latvia, Lithuania and Estonia. This way, the geoid model can be tested and verified on larger areas, thus contributing to certainity concerning the precision of the geoid model. I class geodetic network between Lithuania, Latvia and Estonia is physically levelled.

References

1. Celms A., Bimane I., Reke I. (2014). *European Vertical Reference System in Baltic Countries.* In Baltic Surveying. - Vol.1, pp. 49–55.
2. Celms A., Eglaja E., Ratkevics A. (2015). Latvia Positioning System Base Station Installation in Valka. Сучасні досягнення геодезичної науки та виробництва: збірник наукових праць Західного геодезичного товариства УТГК / Західне геодезичне товариство Українського товариства геодезії і картографії. Національний університет "Львівська політехніка" - Львів, 2015. - Вип.1(29), с. 39-43
3. Celms A., Helfrica B., Kronbergs M. (2007). Результаты нивелирования I класса в западной части Латвии (I Class Leveling Works in West Part of Latvia). In BALTIC SURVEYING `07 Internationalscientific-methodicalconference pp.14-18. Kaunas. (In Russian)
4. Celms A., Kronbergs M., Cintina V. (2012). Accuracy Estimation of the Latvia First Order levelling Network. In International scientific and technical conference GEOFORUM 2012 pp.44 – 47. Lvivska Politehnika.
5. Celms A., Kronbergs M., Cintina V., Baumane V. (2013). Precision of Latvia Levelling Network Nodal Point Height. In CIVIL ENGINEERING`13 4th International Scientific Conference, Volume 4 pp. 310-317. Jelgava.
6. Celms A., Ratkevics A., Rusins J. (2014). *Research of National Geodetic Network Elevations at Eastern Part of Latvia.* In Baltic Surveying. - Vol.1, pp. 84–91.
7. Celms A, Reke I., Ratkevics A. (2015). European Vertical Reference System Influence in Latvia. In 2nd International Conference Innovative Materials, Structures and Technologies, 30 September – 2 October 2015 p. 30. Riga: Riga Technical University
8. *Latvijas kvaziģeoīda modelis* (Latvian quasigeoid model). (2015). Retrieved 11 March, 2015, from http://map.lgia.gov.lv/index.php?lang=0&cPath=2&txt_id=130 (In Latvian)
9. Lazdans J., Aleksejenko I., Kaminskis J., Celms A., Kalinka M., Klive J., Reiniks M. (2009). Aktualitāte Latvijas sasaistē ar Eiropas augstumu sistēmu (Current Events Latvia Connecting with European Height System). LatviaUniversity scientific conference No.67.
10. Reiniks M., Lazdans J., Ratkus B. (2010). Valsts augstuma izejas līmeņa noteikšana (Determination of state height datum level). *Riga Technical University scientific articles.* Nr.7, 7-13. lpp. (In Latvian)

Information about authors

Armands Celms, Dr.sc.ing., assistant professor, Department of Land Management and Geodesy, Faculty of Rural Engineering, Latvia University of Agriculture. Address: Akademijas Street 19, Jelgava, LV–3001. E-mail: armands.celms@llu.lv

Jānis Rusiņš, Mg.sc.ing., lector, Department of Land Management and Geodesy, Faculty of Rural Engineering, Latvia University of Agriculture. Address: Akademijas Street 19, Jelgava, LV–3001. E-mail: jrusins@inbox.lv

Ilona Reķe, Mg.sc.ing. Department of Land Management and Geodesy, Faculty of Rural Engineering, Latvia University of Agriculture. Address: Akademijas Street 19, Jelgava, LV–3001. E-mail: ilona.reke@gmail.com

ENVIRONMENTAL FACTORS INFLUENCING URBAN LAND USE

Rūta Dičiūnaitė-Rauktienė[1] and Vida Maliene [1,2]
[1] Aleksandras Stulginskis University,
[2] Liverpool John Moores University

Abstract
A clean and healthy environment can be considered as the greatest fortune which humanity possesses and upon which the survival and existence of the humankind depend. The urban environment and its physical quality are especially important because of the population migration to the cities. In the last decades of the 20th c. people more often leave the countryside and move to live in the cities, as the result, the environmental pollution and the usage of natural resources are increasing. The daily small and large-scale activities of the cities and regions one way or another contribute to the total effect of the urban land on the environment. The more people there are, the more serious problems arise. The environmental factors in the urban land are especially important and form an integral part of the sustainable development priorities. In order to protect the environment, it is important to evaluate the environmental criteria which will influence the urban land use.
The aim of the article: to point out the environmental criteria influencing the urban land use on the basis of the literature review. The object of the article – the environmental criteria influencing the urban land use. The analysis was conducted using the methods of scientific publications, statistical analysis and synthesis. This is the review article.
Key words: urban land, environmental criteria, land use.

Introduction

Currently, the process of urbanisation changes the view of the Earth‘s surface, climate and biodiversity the most (Grimm et. al. 2008, Seto et. al., 2011).
200 years ago only 3 % of the humankind lived in the cities. However, lately people more often leave the countryside and move to live in the cities (Thomas, 2008), the movement has been noticed since 1800 (Muggah, 2012), in 1900, 13 % of the population lived in the cities, in 1950 – 30 % of the population, in 2005 – 49 % (O'Neill et. al. 2012), in 2014 – 54 %, and in 2050 at least 66 % of the population is considered to live in the cities (World Urbanization Prospects, 2014). It means that more than a half of the world population already lives in the cities (Griffith, 2009).
The rapid processes of the urbanisation influence the density of development, traffic intensity resulting in the increase of environmental pollution and this negatively influences the life quality and health of the population. According to J. Vanagas (2008), the main aim of the city planning is to create the best living, work and leisure conditions for the people, protect their health from the harmful effect of natural, industrial and other conditions. Therefore, in order to protect the environment, it is important to evaluate the environmental criteria which will influence the urban land use.
The object of the article - the environmental criteria influencing the urban land use.
The aim of the article: to point out the environmental criteria influencing the urban land use on the basis of the literature review.
Objectives:

- to analyse the changes of urbanisation;
- to analyse the factors influencing the life quality in the urban land;
- to point out the environmental criteria influencing the urban land use.

Methodology of research and materials

The analysis was conducted using the methods of scientific publications, statistical analysis and synthesis.

Discussions and results

The changes of urbanisation (population migration from the countryside to the city and rapid increase of the cities) were influenced by the need of manpower in the cities (Oluwatayo, Opoko, 2014) and the increasing human population (in 1930 there were about 2 billion people, in 2014 – about 5.8 billion, in 2025 m. – the number of people should reach 8.5 billion) (World Bank, 2015). It is believed that the urbanisation will continue to grow rapidly, especially in the less developed countries (Fig. 1).

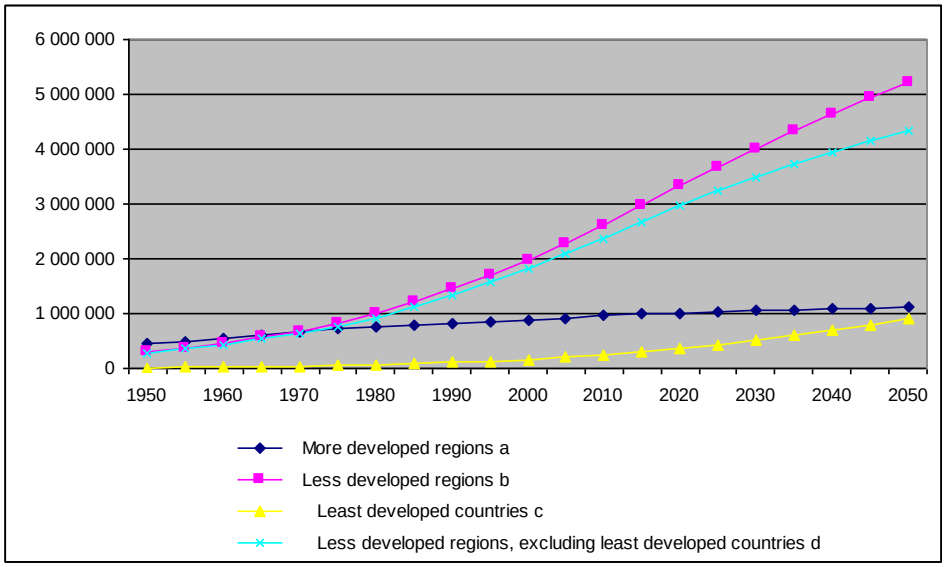


Fig.1. Urban and rural population in less and more developed regions

Source: United Nations, Department of Economic and Social Affairs, Population Division, 2014 World Urbanisation Prospects: The 2014 Revision, custom data acquired via website.

Symbol	Description
a	More developed regions comprise Europe, Northern America, Australia/New Zealand and Japan.
b	Less developed regions comprise all regions of Africa, Asia (excluding Japan), Latin America and the Caribbean plus Melanesia, Micronesia and Polynesia.
c	The least developed countries are 49 countries, 34 in Africa, 9 in Asia, 5 in Oceania plus one in Latin America and the Caribbean.
d	Other less developed countries comprise the less developed regions excluding the least developed countries.

As it can be seen in Figure 1, the urbanisation has been growing rapidly since 1950. Less rapid growth was recorded only in the more developed regions.

The urban lands are divided according to the population number: small urban land - when the population is less than 200.000; medium-sized - when the population is 200.000 – 500.000; city - population is 500.000 – 1.5 million; large city - when the population is more than 1.5 million (OECD, 2013).

The cities with million inhabitants are growing rapidly (Fig. 2). Different statistical sources sometimes present different population number of the same cities. These differences occur because the population number of large cities can be taken only from the main city or the whole agglomeration (Demographia World Urban Areas, 2015).

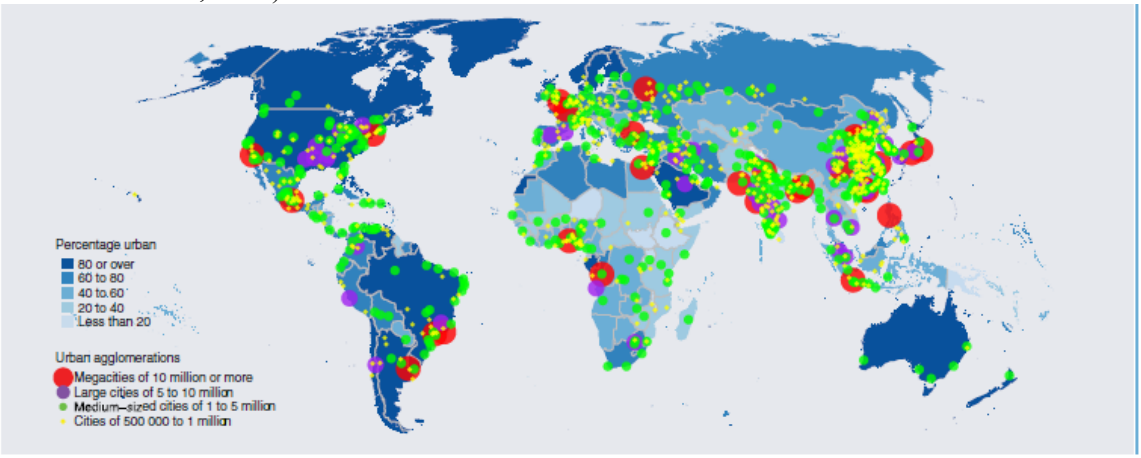


Fig. 2. Percentage urban and location of urban agglomerations with at least 500,000 inhabitants, 2014 Source: World Urbanization Prospects. The 2014 Revision. Highlights

As it can be seen, the level of urbanisation in various countries differs greatly. According to this rate, the countries can be divided into three groups: countries of high urbanisation rate – the level of urbanisation is greater than 70 %; countries of average urbanisation rate – the level of urbanisation is 40–70 %; countries of low urbanisation rate – the level of urbanisation is less than 40 %.

The urban environment is mostly described as the city environment, as physical, cultural, social environment, which binds the group of people living in a compact manner (Clark, 2009). The physical (natural) parts of the environmental components can be considered to be the environmental air, climate, flora, soil, etc., however, the artificial phenomena and objects, such as infrastructure, buildings, traffic jams, noise, etc., can be ascribed to them as well. In the cities these components influence the life quality, conditions and activities of the humans the most. Therefore, the urban land use has to be well-judged and sustainability components have to be considered (Daily et. al. 2009, Goldstein et. al. 2012, Nelson et. al. 2009, Viglizzo et al. 2012, Yeg, Huang, 2009). For example, when carrying out the construction works in the urban land the possibility of too high population density, the significant decrease of greening, the possibility of the traffic jams should be considered (Mickaityte et. al. 2008; Baltrenas et al., 2007) as all this influences the condition of environmental quality and the population life quality in the urban land.

Deveikis et. al. (2014) emphasise the importance of the green spaces in the cities, since they capture 20–86% of dust, positively influence the microclimate and protect from the pollution and noise. Moreover, they support the spatial expression of landscape (Deveikiene, 2015).

According to Vanagas (2008), the main quality indicators of the inhabited area can be considered to be the communication, noise and air quality. However, according to other authors (Gerikiene, Malakauskiene, 2013), the environmental quality in the cities can be evaluated on the basis of various aspects, which depend on the living conditions as well as on various physical elements. However, in the urban land, the main factors can be considered to be air pollution and quality, water pollution, physical pollution (noise); waste management; soil quality, green spaces and open spaces, protected areas, visual quality.

As the population number in the cities (urban land) is growing, the population density grows as well, the result of which is the increase of the traffic intensity (Browne, 2012). The air pollution caused by the transport negatively influences life quality of the populations, harms the historic buildings and flora (Vlachokostas et al. 2010), negatively influences the environment, i.e., causes the climate change (Clark, 2009; Czischke et al., 2015), the increase of the greenhouse effect (Sostak, 2011). Thus, the most serious problem prevailing in the urban land is great air pollution in large cities (Guerreiro et. al. 2014; Hardoy et. al. 2013, Vlachokostas et. al. 2011), which, according to the data of the conducted analysis, influences the majority of people (morbidity of diseases associated with the environmental pollution) living in the city (Dockery, Pope, 2006, WHO, 2003). Therefore, it can be stated that air pollution in the cities is one of the most important factors of the environmental quality (Chen, Kan, 2008).

The biggest problem of the air quality of European cities is too high concentration of the particulate matter (PM_{10}) in the air (Fig. 3).

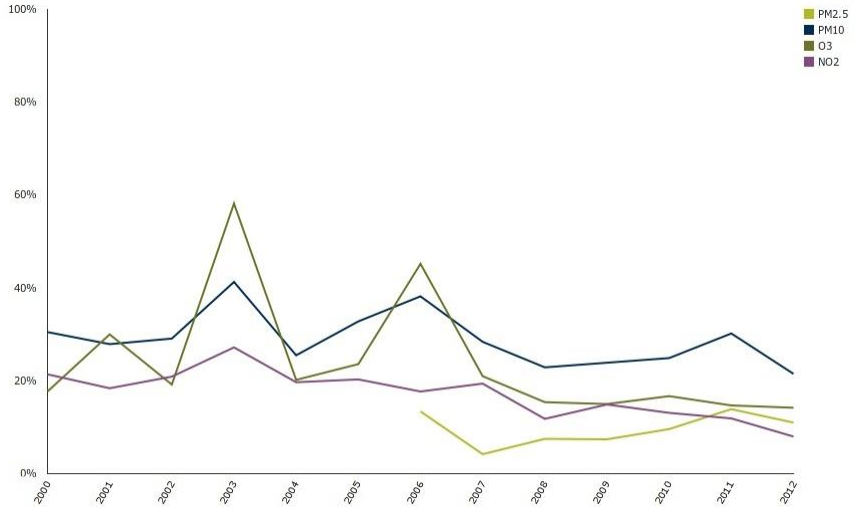


Fig. 3. Urban population to air concentrations above selected limit and target values
Source: European Environment agency, 2015

Criteria:

Percentage of population exposed to annual $PM_{2.5}$ concentrations above 25 $\mu g/m^3$.

Percentage of population exposed to daily PM_{10} concentrations exceeding 50 μg/m^3 for more than 35 days a year.
Percentage of population exposed to maximum daily 8 hour mean O_3 concentrations exceeding 120 μg/m^3 for more than 25 days a year.
Percentage of population exposed to annual NO_2 concentrations above 40 μg/m^3

From the data submitted by the European Environment Agency, in the period of 2001–2011, the daily limit value for PM_{10} (50 μg/m^3) was exceeded by 20-44 per cent in the urbanized areas of EU-27, however, the permitted number of days when air pollution PM_{10} may exceed the limit value (35 days) was mostly exceeded in 2003, 2006, and 2011 (European Environment Agency, 2013).
A similar situation occurs with nitrogen dioxide (NO_2) - in the analysed period of 2001–2011the average annual NO_2 limit value (40 μg/m3) was exceeded by 5-23 per cent, it also occurs with ozone (**O_3**), which is considered to be the most prevalent pollution affecting the human health (Xu et. al, 2015). 2001–2011, 14–65 % of the urban population in EU-27 was exposed to ambient ozone concentrations exceeding the EU target value set for the protection of human health (120 microgram O_3/m^3 daily maximum 8-hourly average, not to be exceeded more than 25 times a calendar year, averaged over three years and to be achieved where possible by 2010). Sulphur dioxide (SO_2) in the period of 2001–2011 exceeded the permissible norms as well (European Environment Agency, 2015) (Fig. 4).

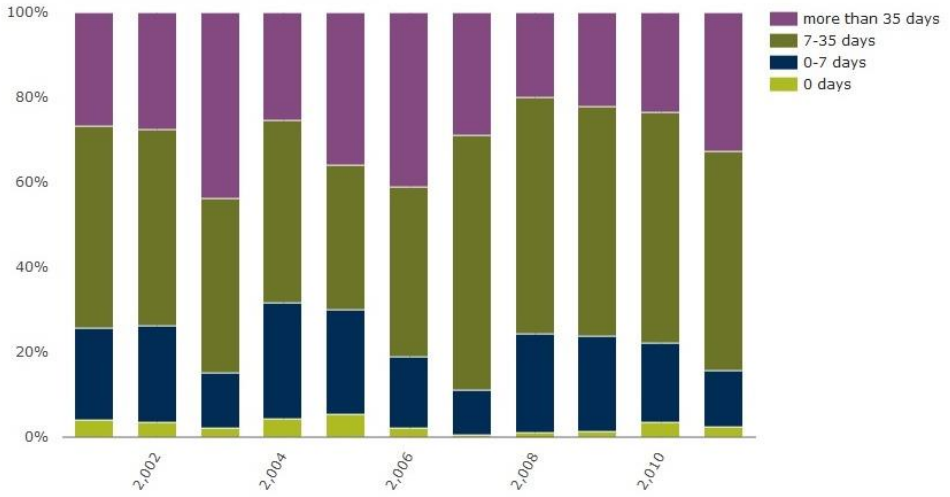


Fig. 4. Percentage of urban population resident in areas for days per year with PM10 concentration exceeding daily limit value
Source: European Environment agency, 2015

The limit value is 50 μg PM10/m3 (24 hour average, i.e. daily), not to be exceeded more than 35 times a calendar year. Over the years 2001–2011 the total population for which exposure estimates are made, increased from 66 to 149 million people due to an increasing number of monitoring stations reporting air quality data under the Exchange of Information Decision. Air quality and pollution are also determined by benzo(pyrene), which is emitted into the environment by gas exhausted by transport or by stationary combustion plants (Aplinkos oro kokybės vertinimo vadovas, 2006). The target value (1 ng/m^3) of benzo(a)pyrene in large cities that was estimated in 2012 and introduced from 31 December, 2012, has been exceeded (European Environment Agency, 2013).
Thus, it can be said that the urban environment and its physical quality is particularly important with regard to human migration to cities. In addition to ecological phenomena, the urban environment affects social phenomena as well. Due to rapid population growth, urban land of the developed and developing countries face a number of environmental problems. Urban environmental problems that specifically determine the quality of life in urban land and that should be paid the greatest attention can be distinguished as follows: extinction of biodiversity, decrease in green spaces, air quality problems due to traffic emissions resulting in detriment to vegetation and historic buildings, increase of greenhouse effect, climate change, and increase of environmental pollution-related diseases (Fig. 5).

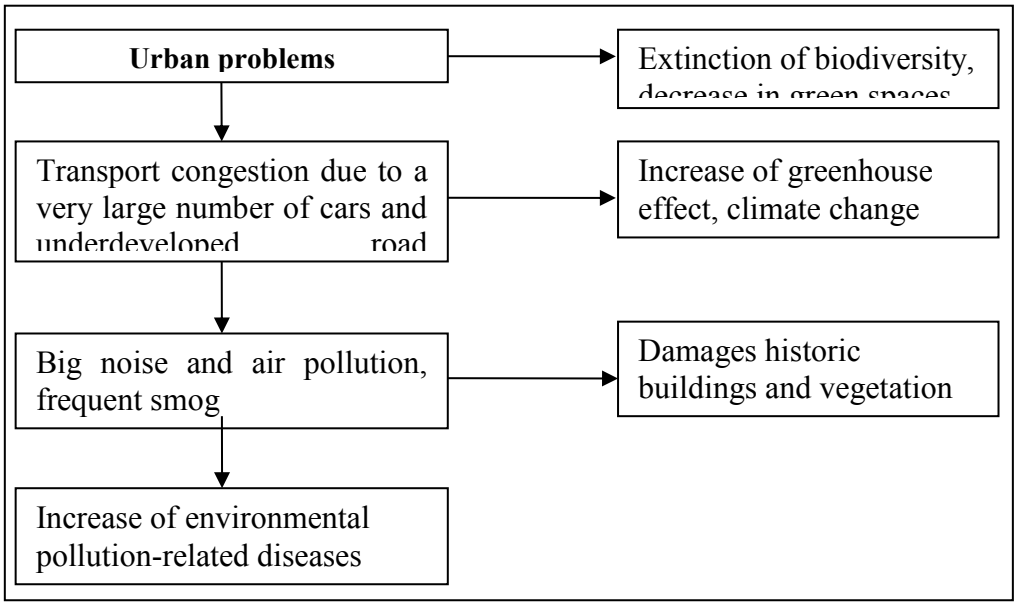


Fig. 5. Major environmental problems of cities determining the quality of life in urban areas

Thus, rapid processes of urbanization also determine building density, resulting in increasing environmental pollution, which affects the quality of life and health adversely. According to Vanagas (2008), the main urban planning goal is to give people the best living, working, and recreation conditions, to protect their health from harmful natural, industrial and other impact. Therefore, developing master plans of the cities, it is important to lay out the industrial areas in such a way that emissions of industrial companies would have minimum impact on adjacent areas. Areas that are protected from harmful effects and best meet the ecological needs should be allocated to the living area (Vanagas, 2008).

According to Baltrenas et al. (2008), the reduction of pollution is one of the most important environmental tasks. The reduction of urban air pollution and clearing and cleaning of sites contaminated with hazardous chemicals will protect population from harm and will preserve their health. The reduction of carbon dioxide is important in improving traffic conditions and reducing the negative environmental impact of transport.

Therefore, it can be said that the main environmental criteria that should be taken into account when planning the use of land in urban areas have to be linked with the reduction of air pollution and maintenance of ecological balance (Fig. 6). This requires urban regeneration, which must include the establishment of harmonious and attractive environment – establishing "the compact building of residential areas" and quality infrastructure (Grazuleviciute - Vileniske, Urbonas, 2013, p.82).

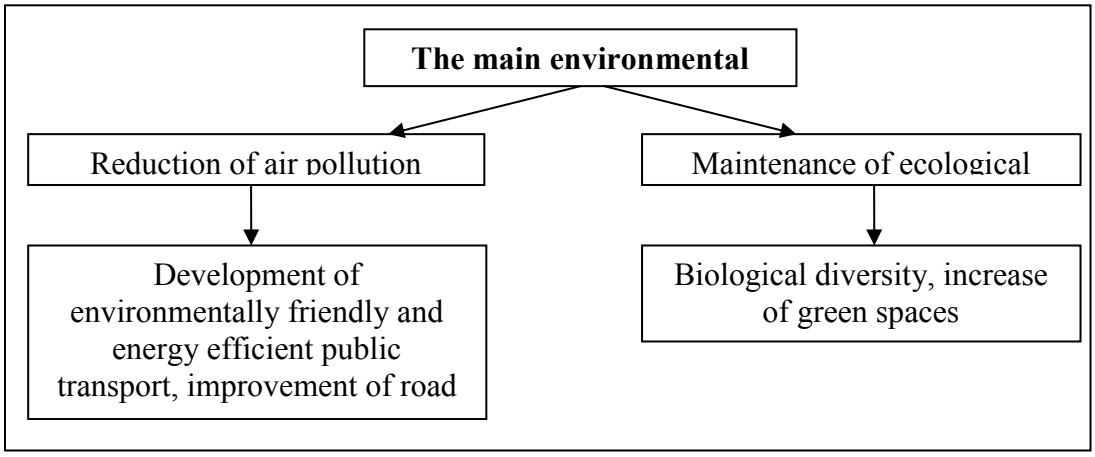


Fig. 6. The main environmental criteria

European Economic and Social Committee (ECO/273, 2010) also expressed the opinion on "the need for an integrated approach to urban regeneration", which states that ordinary urban measures in

modern cities are inefficient, because "the city has now become not only an energy wasting system, but also one of the main causes of environmental change. Therefore, it is important that while fighting harmful CO_2 emissions and climate change, EU would coordinate its actions and seek after more decisive policy of urban regeneration". It is also indicated that the objective of urban regeneration policy is "to integrate sustainable transport and energy systems", and that "the priority is given to an integrated urban regeneration model". Urban regeneration has to take into account the decaying of green spaces, which results in decreasing biodiversity (ECO/273, 2010), as well as transport systems in order to reduce energy use and pollution (ECO/273, 2010; Balaban, Puppim de Oliveira; 2014).

Conclusions and proposals

The parts of natural environment components are as follows: ambient air, climate, vegetation, soil, artificial phenomena and objects - infrastructure, buildings, traffic jams, noise, etc. In cities these components mostly determine the quality of life, conditions and activities. Therefore, the use of land in urban areas has to be well- judged and should take into account the sustainability components, because all of this determines the environmental quality status and the quality of life of population in urban areas.

Urban land where industrial constructions and traffic congestion regularly occurs faces with increased pollution, noise, dust, so in order to maintain a healthy and harmonious environment, it is important to use land in accordance with the environmental requirements. Failure to comply with these requirements will result in the increase of air pollution having an adverse effect to the environment and people living there. In compliance with the current situation and future trends discussed, we can say that in order to protect the environment in urban land, it is important to assess environmental criteria, which will determine the land use in urban areas.

In order to improve the urban environment, it is important to take appropriate air pollution measures.

Therefore, developing master plans of the cities, it is important to lay out the industrial areas in such a way that emissions of industrial companies would have minimum impact on adjacent areas. Areas that are protected from harmful effects and best meet the ecological needs should be allocated to the living area. In order to improve road infrastructure, it is important to develop environmentally friendly and energy efficient transport and maintain the balance by increasing the number of green spaces and biodiversity.

References

1. Aplinkos oro kokybės vertinimo vadovas. Nacionalinių taršos mažinimo bei oro kokybės vertinimo programų paruošimas. 2006. Viewed 10 January (2016) (http://gamta.lt/files/Aplinkos_oro_kokybes_vertinimo_vadovas.pdf).
2. Balaban O., Puppim de Oliveira J.A. (2014). Understanding the links between urban regeneration and climate-friendly urban development: lessons from two case studies in Japan, *Local Environment*, 19:8
3. Baltrėnas P., Vaitiekūnas P., Vasarevičius S., Jordanech S. (2008). Automobilių išmetamų dujų sklaidos modeliavimas. *Journal of environmental engineering and landscape management*, 16(2), p.65–75.
4. Browne M., Allen J., Nemoto T., Patoer D., Visser J. (2012). Reducing Social and Environmental Impacts of Urban Freight Transport: A Review of Some Major Cities. *Procedia - Social and Behavioral Sciences*, Vol. 39, p. 19-33.
5. Chen B., Kan H. (2008). Air pollution and population health: a global challenge. *Environ Health Prev Med*, 13(2), p. 94–101.
6. Clark A.L. (2009). Environmental Challenges to Urban Planning: Fringe areas, Ecological Foot prints and Climate Change. *Governance, Socio-Economic, and Environmental Issues Workshop*, p.1-8.
7. Czischke D., Moloney C., Turcu C. (2015). Raising the game in environmentally sustainable urban regeneration. Sustainable regeneration in urban areas. Viewed 2 March, 2016 (http://urbact.eu/sites/default/files/04_sustreg-web.pdf).
8. Daily G.C., Polasky S., Goldstein J., Kareiva P.M., Mooney H.A., Pejchar L., Ricketts T.H., Salzman J., Shallenberger R. (2009). Ecosystem services in decision making: time to deliver. *Front. Ecol. Environ*, 7, p. 21–28.
9. Deveikis S., Deveikienė V., Deveikytė O. (2014). Parkų kūrėjas Charles (Carlos) Thays– europietiškoji tradicija Pietų Amerikoje ir jos grįžtamasis ryšys. *Miestų želdynų formavimas*, 1(11), p.34–49.
10. Deveikienė V. (2015). Kraštovaizdžio architektūros ir urbanistikos sąveika - ar turime bendrą tikslą. *Mokslas - Lietuvos ateitis*, 7(1), p.6-19.

11. Definition of Functional Urban Areas (FUA) for the OECD metropolitan database. 2013. Viewed 10 January, 2016. (http://www.oecd.org/gov/regional-policy/Definition-of-Functional-Urban-Areas-for-the-OECD-metropolitan-database.pdf).
12. Demographia World Urban Areas. 11th annual edition. (Built Up Urban Areas or World Agglomerations). 2015. Viewed 22 January, 2016. (http://www.demographia.com/db-worldua.pdf).
13. Dockery D.W., Pope C.A. (2006). Health effects of fine particulate air pollution: lines that connect (2006 critical review). *Journal of the Air & Waste Management Association*, 56, p. 709–742.
14. Exceedance of air quality limit values in urban areas. European Environment agency. Viewed 22 January, 2016. (http://www.eea.europa.eu/data-and-maps/indicators/exceedance-of-air-quality-limit-1/exceedance-of-air-quality-limit-5).
15. Gerikienė V., Malakauskienė R. (2013). Miestų želdynų for mavimas. *Klaipėdos miesto aplinkos kokybės analizė,* 1(10), p. 71–79.
16. Goldstein H., Caldarone G., Duarte T.K., Ennaanay D., Hannahs N., Mendoza G., Polasky S., Wolny S., Daily G. (2012). Integrating ecosystem-service tradeoffs into land-use decisions. *Proc. Natl. Acad. Sci*, 109, p. 7565–7570.
17. Gražulevičiūtė-Vileniškė I., Urbonas V. (2013). Miestų centrų regeneracijos tendencijos: miesto-sodo koncepcijos persvarstymas. *Miestų želdynų formavimas*, 1(10) 80–94.
18. Griffith C., (2009). Introduction to the Issue. *Urbanization: A critical Human dimension og global environmental change. UGEC Viewpoints*, No. 2, p.4 -6.
19. Grimm N.B., Faeth S.H., Golubiewski N.E., Redman C.L., Wu J.G. (2008) Global change and the ecology of cities. *Science*, 319, p.756–760.
20. Guerreiro C.B.B., Foltescu V., Leeuw F. (2014). Air quality status and trends in Europe. *Atmospheric Environment.* Vol. 98, p.376–384.
21. Hardoy J.E., Mitlin D., Satterthwaite D. (2001). *Environmental Problems in an Urbanizing World: Finding Solutions in Cities in Africa, Asia and Latin America*. Routledge, 342 p.
22. Yeh C.T., Huang S.L. (2009). Investigating spatiotemporal patterns of landscape diversity in response to urbanization. *Landsc. Urban Plann*, 93, p. 151–162.
23. Kompleksinė miestų regeneracija. ECO/273. 2010. Ekonominės ir pinigų sąjungos, ekonominės ir socialinės sanglaudos skyriaus nuomonė dėl Būtinybės kompleksiškai vykdyti miestų regeneraciją.
24. Muggah, R. (2012). Researching the Urban Dilemma: Urbanization, Poverty and Violence, IDRC, Ottawa. Viewed 22 January, 2016. (http://www.idrc.ca/EN/PublishingImages/Researching-the-Urban-Dilemma-Baseline-study.pdf).
25. O'Neill B. C., Ren X., Jiang L., Dalton M. (2012). The effect of urbanization on energy use in India and China in the iPETS model Energy Economics, 34, p. 339-345.
26. Nelson E., Mendoza G., Regetz J., Polasky S., Tallis H., Cameron D.R., Chan K.M.A., Daily G.C., Goldstein J., Kareiva P.M., Lonsdorf E., Naidoo R., Ricketts T.H., Shaw M.R. (2009). Modeling multiple ecosystem services, biodiversity conservation, commodity production and tradeoffs at landscape scales. *Front. Ecol. Environ*, 7, p. 4–11.
27. Opoko A.P., Oluwatayo A. (2014). Trends in Urbanisation: Implication for Planning and Low-Income Housing Delivery in Lagos, Nigeria. *Architecture Research*, 4(1A), p.15-26.
28. Seto K.C, Fragkias M., Guneralp B., Reilly M.K. (2011). A Meta-Analysis of Global Urban Land Expansion. *PLoS ONE* , 6(8): e23777.
29. Šostak O.R. (2011). Statybų plėtros urbanizuotose teritorijose neigiamo poveikio vietinei aplinkai įvertinimas. *Statyba. Mokslas- Lietuvos ateitis*, 3(2), p.39-44.
30. Thomas S. (2008). Urbanization as a driver of change The Arup Journal 1/2008 pp58-67 Trivedi, J. K., Sareen, H. and Dhyani, M. (2008): Rapid urbanization - Its impact on mental health: A South Asian perspective, *Indian Journal of Psychiatry*, 50(3), p.161–165.
31. Urban and rural population in less and more developed regions. United Nations, Department of Economic and Social Affairs, Population Division (2014). World Urbanization Prospects. Viewed 22 January, 2016. (http://www.eea.europa.eu/data-and-maps/figures/urban-population-resident-in-areas-pollutant-limit-target).
32. Vanagas J. (2008). *Urbanistikos pagrindai*. Vilnius, 244p.
33. Viglizzo E.F., Paruelo J.M., Laterra P., Jobbágy E.G. (2012). Ecosystem service evaluation to support land-use policy. *Agr. Ecosyst. Environ*, 154, p. 78–84.
34. Vlachokostas Ch., Nastis S., Achillas Ch., Kalogeropoulos K., Karmiris I., Moussiopoulos N., Chourdakis E., Banias G., Limperi N. (2010). Economic damages of ozone air pollution to crops using combined air quality and GIS modelling. *Atmospheric Environment*, 44, p.3352–3361.
35. Vlachokostas Ch., Achillas Ch., Moussiopoulos N., Banias G. (2011). Multicriteria methodological approach to manage urban air pollution. *Atmospheric Environment*, Vol. 45, Issue 25, p.4160-4169.
36. World Health Organisation (WHO). Health Aspects of Air Pollution with Particulate Matter, Ozone and Nitrogen Dioxide Viewed 24 January, 2016. (http://www.euro.who.int/__data/assets/pdf_file/0005/112199/E79097.pdf).

37. World Urbanization Prospects. The 2014 Revision Highlights. Department of Economic and Social Affairs.United Nations. New York, 2014 Viewed 22 January, 2016. (http://esa.un.org/unpd/wup/Highlights/WUP2014-Highlights.pdf).
38. World bank data. World development. Viewed 23 January, 2016. (http://databank.worldbank.org/data/reports.aspx?source=2&type=metadata&series=SP.URB.TOTL.IN.ZS#).
39. Xu S., Xingyuan H., Chen W., Huang Y., Yi Z., Li B. (2015). Differential sensitivity of four urban tree species to elevated O_3. *Urban Forestry & Urban Greening*. Vol. 14, Issue 4, p. 1166–1173.

Information about authors

Rūta Dičiūnaitė - Rauktienė is a Phd student studying at the Land Management and Geomatics Institute, Faculty of Water and Land Management, Aleksandras Stulginskis University. Her current area of study surrounds the topic of development of the model for cities sustainable highstreets. Contact details: Land Management and Geomatics, Faculty of Water and Land Management,Aleksandras Stulginskis University, Universiteto 10, Akademija, Kaunas 53361, Lithuania, E-Mail: diciunaite200@yahoo.com, Tel: +37067267090.

Vida Maliene, PhD, is a Reader in Property and Planning studies at the School of the Built Environment and an active member of the Built Environment and Sustainable Technologies (BEST) Research Institute, both at Liverpool John Moores University in the UK. Vida is a Visiting Professor at Institute of Land Management and Geomatics in Aleksandras Stulginskis University, Lithuania. Her research focuses on Property and Planning including such related subjects as Spatial and Urban Planning, Urban Regeneration and Sustainable Communities, Land Management and Economics, Property Valuation and Taxation. Vida has published over fifty scientific papers in International peer-reviewed academic journals and conference proceedings, a book/monograph, eleven book chapters and several journal editorials. She is a fellow of the Higher Education Academy, member of Executive Board of European Academy of Land Use and Development (EALD) in Zürich, member of the European Group of Operational Research and the International Council of Research and Innovation in Building and Construction (CIB). Contact details: Department of the Built Environment, Liverpool John Moores University, Byrom street, Liverpool L3 3AF,United Kingdom; email:v.maliene@ljmu.ac.uk; Tel.: +44-(0)-151-231-2854.

TRANSFER OF AGRICULTURAL LAND PROMOTING THE ECONOMIC GROWTH IN THE ENVIRONMENT AFFECTED BY ANTHROPOGENIC PROCESSES

Rimvydas Gaudėšius[1], Virginija Gurskienė[1], Vida Malienė [1,2]
[1] Aleksandras Stulginskis University,
[2] Liverpool John Moores University

Abstract
Land is a highly important component of the ecosystem determining the existence and variation of other natural resources. Most commonly land is used for urbanization and agricultural development. Either of the said human activity is identified as an anthropogenic impact on natural environment. In order to reduce the negative human impact on the environment, but to promote economic and social development, international political agreements are signed in pursuance of the creation of sustainable development conceptions. The real estate market is an important integral part of the state economy and this market reflects the visible impact of anthropogenic factors and the need of sustainable development. The scientific article aims at examining the agricultural land market in administrative territories of Lithuanian cities and at assessing the legal regulation of the land market in practice. The study revealed that in the areas of Lithuanian cities there is a significant amount of agricultural land, therefore the appropriate transfer of such land can stimulate the economic growth. The investigation showed that it is reasonable to distinguish different regulation measures of agricultural land market for urban areas and for rural areas.
Key words: agricultural land, land market, economic growth, anthropogenic environment.

Introduction

In the twentieth century, scientific and technical revolution significantly increased the human impact on the environment. Agriculture and industry are changing human relation with nature. Anthropogenic effects gained a dramatically large scale even in a global sense (Kalenda, 2000).

In his philosophical article, Č. Kalenda widely reviews the human anthropogenic impact on the environmental from different angles, however, mostly emphasizes that this process is a consequence of the natural human desire to seek his own benefit regardless of the remaining negative effects.

In order to overcome negative and global anthropogenic effects and to continue to pursue sustainable economic and social development, various international indicators and indexes have been determined. The pursue of sustainable development can be controlled by monitoring and comparing relevant indicators of different years.

There are over 500 economic, social and environmental indicators of sustainable development. In Lithuania in 2007, during the preparation of Amendments of the National Strategy for Sustainable Development, the list of sustainable development indicators was completed with reference to the EU recommendations, and now it comprises almost a hundred indicators (Čiegis et al., 2011).

In the modern world the economic growth is mostly assessed by applying the classical growth models. Exponential growth, combined income – these are the growth measurement principles, which are most commonly used in the modern economy to evaluate money and capital flows, return on investment. However, the growth cannot be endless. The logistical theory of capital management is characterized by the fact that it takes into account the limits of growth. The theory states that there is some degree of the capital (investment) capacity, expressing the greatest amount of the capital, which can be effectively absorbed in that environment. When the capital reached the limit from which it cannot be productively absorbed, the system ceases to grow. The maximum capital amount or the limit at which the bubble is formed in the economy may be expanded in two ways – by the state manufacturers expanding the system, i. e. expanding the markets, or by developing the technology, thus increasing the system's ability to effectively absorb the capital (Girdzijauskas et al., 2009).

As already mentioned, two major anthropogenic factors are urbanization and agriculture. However, Lithuanian scientists examining rural development note that chaotic urbanization process adversely affects the agriculture itself, i. e. the land suitable for agriculture is inadequately used (Aleknavičius et al., 2011; Gaudėšius 2014).

Inadequate spatial planning affects not only agriculture, but also the countryside. For a long time the world's landscape has been left to drift, focusing on the air, water and biodiversity issues. As a result, in many regions landscapes degraded as geosystems, lost their aesthetic and ethno-cultural values (Pileckas, 2004).

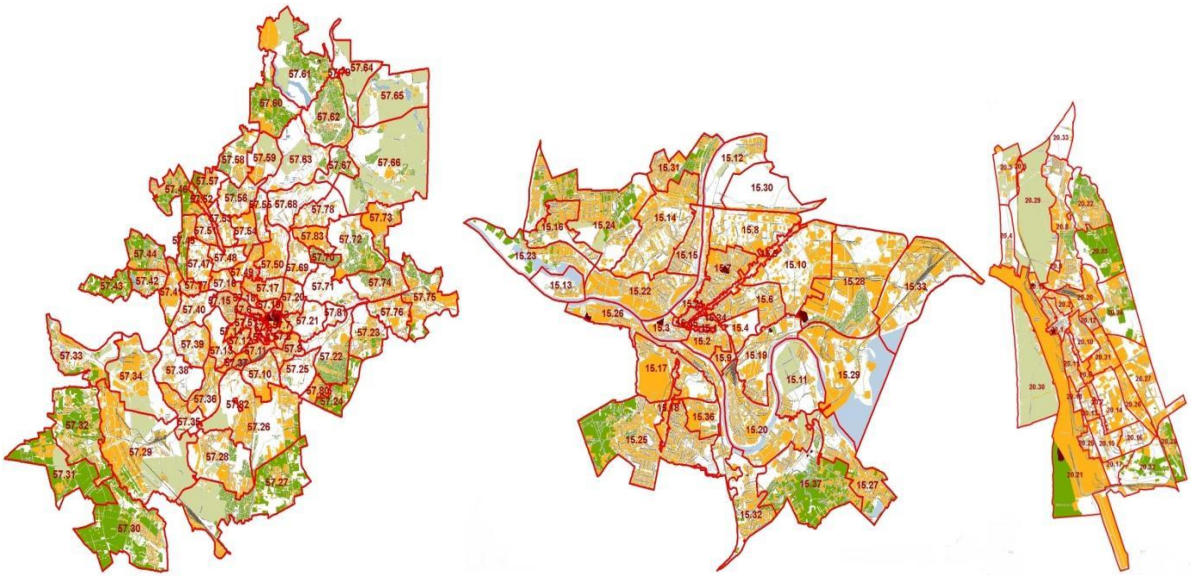
In order to ensure the rational use of land and the economic growth, it is proposed to regulate the land market by law providing a variety of "safeguards" controlling the speculative resale of agricultural land and promoting competitive and stable development of farms (Aleknavičius, 2007). This experience is used in many countries, and this market is regulated applying different methods. The study of international literature allows to find different opinions about a positive or negative impact of such land market regulation on the economy (Lipski, 2015; Ciaian et al., 2012; Cheshire et al., 2004).
The main reason why the agricultural land market is so active in Lithuania is the restoration of land during the land reform to unemployed persons, from whom the current land users, i. e. agricultural entities, buy the land, which they use for the development of their farms. The land market is also activated by those who seek financial gain from land resale and rent or intend to build it up. The creation of stable economic structures would allow the land market to occur only when necessary to change the boundaries of the farm land-use or to transfer the whole farm to another person. Also, the decrease and stabilization of the market activity will occur when the need of the large urban population for their own piece of land for a dwelling or a homestead is satisfied (Aleknavičius et al., 2009).
The average amount of land transferred in Lithuania within a year comprises 4-5 % of the private land, while in the Eastern Europe where stable economic structures are prevailing only about 1 % of the private land is transferred, in addition, the most transferable land is not land plots but rather land holdings as farm units. About 15-20 % of land is purchased by persons engaged in the land resale (Aleknavičius et al., 2014).
Taking into account the scientific recommendations on the regulation of the land market, on the 24th of April, 2016, the Parliament of the Republic of Lithuania adopted the Law on the Acquisition of Agricultural Land (Lithuania, ... 2014), which provides new "safeguards" (Gaudėšiaus et al., 2015).
After the adoption of the said law tightening the regulation of the land market, no detailed research has been carried out yet on the actually operation of such legal "safeguards". What are the benefits brought to farmers, investors and land owners. In addition, it is important to determine whether this procedure does not impede the anthropogenic processes of economic growth in affected areas (in the case study - urban areas), because cities is the place where the largest economic activity is carried out .
The research novelty and uniqueness is based on the fact that many researchers focus on the land market surveys in rural areas, forgetting that such activities can also be carried out in cities.
The aim of the research is to analyze the agricultural land market in administrative territories of Lithuanian cities and to determine whether tightening the legal regulation of this market has a positive impact on the economic growth.
The tasks of the research are to identify urban locations suitable for agriculture; to determine legal measures regulating the agricultural land market; to examine the results of the legal regulation of the land market and the market activity.

Methodology of research and materials

The scientific article is written applying the methods of systematic analysis, deduction, induction. Scientific articles and relevant legislation are reviewed and summarized. The comparison of the statistical information of the year 2010-2015 from the State Enterprise Centre of Registers (hereinafter - Centre of Registers) and from the National Land Service under the Ministry of Agriculture (hereinafter – NLS) is provided.
The object of the research – the agricultural land in the major urban territories of Lithuania, the land transfer. The study is focused on Vilnius, Kaunas and Klaipėda cities as the biggest cities of Lithuania, and the urban development of these cities has the greatest impact on the nearest agricultural areas. The agriculture land situated in the territory of Klaipėda city is examined in greater detail as it is exposed by the need of urbanization development.
In order to determine the amount of the agricultural land and their location in urban areas it is reasonable to employ the graphic and statistical data of the Centre of Registers. Taking into account the fact that a significant amount of land suitable for agriculture is determined between the solid urban structure (the city) and irrationally formed suburban areas, it is reasonable to refine the theory how the land market is regulated in Lithuania. This task requires to review and summarize the legislation. Since the legislation include new regulatory measures for the agricultural land, it is important to carry out a scientific research in both theoretical and practical point of view and to assess how these measures operate. The new regulatory procedure for the land market mainly involves NLS, therefore it is a big advantage to examine the data related to the procedure carried out by this institution.

Discussions and results

Chaotic urbanization causes a variety of social, economic and environmental problems. In addition, the said urban development leaves areas suitable for agriculture land in the administrative territories of the city (Fig. 1). Centre of Registers store cadastral data on formed land plots in its databases, therefore such data is the most convenient and appropriate to determine the spatial arrangement of agricultural land and specific areas. The given schemes show that areas suitable for agriculture are situated on the edges of administrative units in the cities under investigation. It can be explained by the fact that new, but often inferior, residential areas are trying to establish themselves away from the solid structure of the city because of the uneven urban development.



a) b) c)

Fig. 1. The arrangement of agricultural land areas (marked in green) in the major cities of Lithuania: a) Vilnius, b) Kaunas, c) Klaipėda

In Lithuanian cities the amount of agricultural land differs (Table 1), the largest share of such land is determined in Vilnius (21.87% of the total area of the city). In Kaunas there is significantly less land suitable for such activities, i. e. 12.67%, while in Klaipėda it comprises 10,91% of the total accounting area. It is necessary to once again point out that these data are presented by Centre of Registers in accordance with the prescribed purpose of the formed land plots, while in the cities there are still many areas where the land is not formed.

Table 1

The distribution of land fund in major cities of Lithuania according to the main purpose of land

Cities	Agricultural land (ha)	Forest land (ha)	Protected areas (ha)	Other land (ha)	State water fund land (ha)
Vilnius	6607*	4652	53	10117	-
Kaunas	966	241	23	6392	-
Klaipėda	684	1562	19	3733	270

*including the land for amateur gardening

The summary of the data published by Centre of Registers allows to suggest that in the major cities of Lithuania there is a significant area (about 20 percent) suitable for agricultural activities. This circumstance is reinforced by the fact that indicators of Centre of Registers still can be complemented by the territories that are not formed as the land plots, however, the NLS allows farmers to temporarily employ these areas for agricultural activities. Surely, the agricultural land temporarily granted to farmers is not included in the land market but increases the total (real) amount of land suitable for agricultural activities in urban areas.

Authors, who explored the land market in Lithuania (Aleknavičius M. et al., 2014; Aleknavičius P. et al., 2009, 2011), suggest the following key regulatory principles for the agricultural land market:

- to determine the appropriate maximum distance from the purchased land to the main farm buildings owned by a natural person or a legal entity;
- to reimburse the loss incurred by the state for the use of agricultural land for other purposes;
- the priority to purchase the agricultural land to be given to persons engaged in agriculture;
- a large area of agricultural land for the establishment of a new economic entity to be purchased only by a person with a business plan, etc.

According to the existing legislation (Lithuania..., 2014) the agricultural land can be purchased by:
1) a natural person with professional skills and competence. It is a natural person who has been engaged in agricultural activities for at least three years within the last ten years to the agricultural land purchase transaction date and who has declared his landed poperty and crops;
2) a legal entity or other organization who has been engaged in agricultural activities for at least three years within the last ten years to the agricultural land purchase transaction date and who has declared his landed property and crops.
In addition, the law limits the total disposable land area, i. e. a person or related persons can acquire as much land in the territory of Lithuania so that the overall area of agricultural land acquired from the state would not exceed 300 hectares, and the total their owned area of agricultural land acquired from the state and other persons would not exceed 500 hectares.
The summary of scientific literature and legislation leads to the conclusion that the agricultural land market is already sufficiently regulated in Lithuania. However, scientific recommendations for the acquisition of land with reference to the distance from the farm buildings (agricultural centre) to the owned land plot still needs to be implemented, and the losses incurred due to the use of agricultural land for construction are still not compensated. As previously mentioned, scientists, who analyzed the agricultural land market, focused on rural areas, therefore the market regulatory principles are more likely to apply for these areas. However, in practice it happens so that the law does not distinguish the regulatory measures for land in urban and rural areas.
According to general plans of Lithuanian cities (spatial planning documents) areas in urban administrative territories suitable for agricultural activities are mainly intended to be used for other, non-agricultural purposes. Because of the market characteristics of real estate, the land suitable for construction is highly expensive, thus the question arises whether the farmer is financially able to compete in these areas, to purchase the land in an urban area and to develop economic activities acceptable for him. It is more likely that the speculative resale of land plots takes place in these areas.
From investors' point of view and taking into account the economic theories, assets are transferred when the other person can gain more advantage from them, i. e. get the maximum benefit from the investment of money. This process promotes the economic growth. It is therefore important that this process would not be overloaded with unnecessary bureaucratic procedures.
A person willing to sell his agricultural land has either directly or through a notary to serve the territorial office of NLS with the notice on the sale of a land plot (including the price and other conditions of sale).
In accordance with the description of the issuance procedure of the statement on the private agricultural land on sale (Statements on..., 2014), the territorial office of NLS performs the administrative procedure and informs owners of neighboring agricultural lands and interested institutions (City Municipality, State Enterprise State Land Fund) about the possibility to acquire the land by priority. Table 2 shows the number of statements on the agricultural land offered for sale, when persons, who have the priority, do not intend to buy it, issued in Klaipėda city in 2014-2015, as well as other statistical information related to the procedure.
The collected statistical information reveals that 87 statements were issued in Klaipėda city over two years. In 2014, more statements were issued to natural persons, while in 2015 – to legal entities (Fig. 2).
It also shows that during this period 114 landowners were interviewed regarding their priority to purchase the agricultural land on sale. Out of these owners only 5 persons exercised their right of priority. However, neither of these individuals met purchase requirements as they failed to submit the necessary documentation.

Table 2

Statistical information regarding issued statements on the agricultural land offered for sale, when persons, who have the priority, do not intend to buy it (within the year 2014- 2015)

General statistical information	Year 2014	Year 2015
Statements issued to natural persons	9	18
Statements issued to legal entities	7	53
Adjacent neighbours informed*	23	91
Cases with no neighbours*	3	14
Drawn letters on the failure to comply with purchase requirements	1	4
Reissued statements	2	3

*Apart from the City Municipal and the State Enterprise the State Land Fund

There were cases (17 issued statements) where there were no land plots formed or the plot on sale neighboured only with the land plot of other purpose (in accordance with legislation, in such cases it is not required to inform neighbours). Within the period of two years, statements were reissued to the same land plot 5 times.

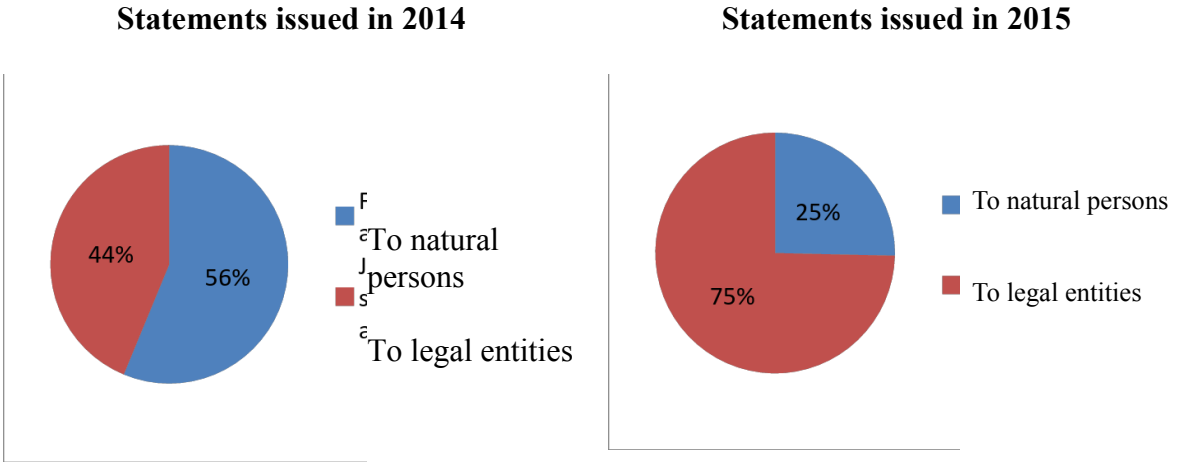


Fig. 2. Distribution of issued statements by recipient as a percentage

Figure 3 presents the data from Centre of Registers on concluded transactions concerning agricultural land plots in Lithuanian cities. Out of the given cities, the largest portion of such transactions concerning agricultural land plots takes place in Vilnius. Solid and steady growth or decrease in the number of transactions cannot be observed in any of these cities. As already mentioned, additional legal "safeguards" have been imposed since 2014 potentially reducing the market activity. In 2014 the decrease in the number of transactions concerning the transfer of agricultural land in Kaunas and Klaipėda is observed, however, in 2015 the number of transactions concluded on the transfer of agricultural land restores its position, and possibly will even exceed the entire period since 2010.

The comparison of the number of statements issued by NLS and the number of transfers of land plots registered in the Centre of Registers suggests that not all issued statements are used. Possibly some statements will be used only after a year or two.

It is reasonable to conduct investigations in other smaller cities of Lithuania and to find out how many people were willing to purchase agricultural land plots exercising their right of priority, and how many of them actually took advantage of it. In Klaipėda city it is apparent that only 5.7 % of statements were issued to such persons within the period 2014-2015. It should also be noted that not all of them could exercise their right of priority as they failed to submit the necessary documentation.

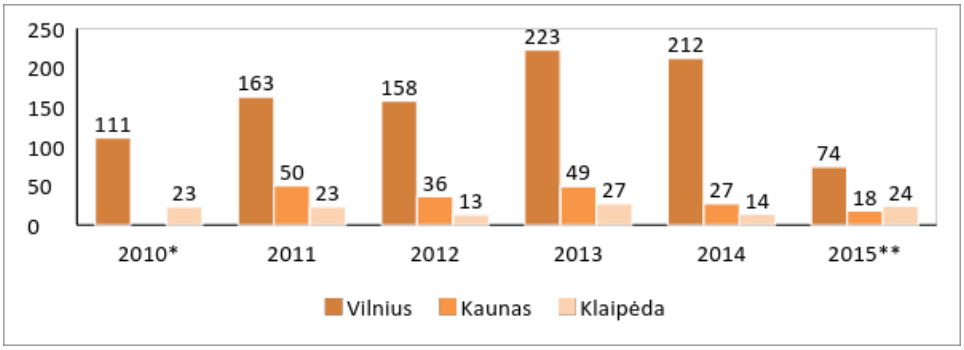


Fig. 3. The number of transactions concerning agricultural land plots in Lithuanian cities

*there are no data on the sale of agricultural land in Kaunas city in 2010

**data on the concluded transactions in 2015 covers only the first half.

There were even 19.5% of cases where a legal obligation to inform adjacent landowners did not apply when issuing the statements. Most commonly other interested bodies (City Municipality, State Enterprise the State Land Fund) informs in advance that they will not exercise their right priority to purchase the agricultural land plots on sale for relevant six months or a year.

The legislation contains a clause that the owner of the land plot on sale must withdraw a new statement when there is a change in the sale conditions. Given the fact that there is no precise indication of what such conditions should be, it can be assumed that it is the change of the contract price. It is therefore necessary to clarify this provision indicating a more accurate term of validity for the statement (specifying the date), simply because land plots participating in the market frequently have their owners changed, thus it is likely that the owner who, for example, withdrew the statement in 2014 will sell a piece of land only in 2016, and a new neighbouring landowner appearing in 2015 will not learn about the adjacent land plot on sale.

To sum up, transactions concerning the agricultural land take place due to different reasons in urban and rural ares. In rural areas, the transfer of agricultural land is mostly carried out for the formation of farms. Urban areas absorb the agricultural land for the construction needs of residential, industrial or commercial facilities. However, regardless of whether the land plot is in the urban or rural administrative area, it can be concluded that constant transfer of land without any actual construction or economic activities in it is a finite process. The new legal “safeguards” in force have no noticeable impact on the agricultural land market in urban areas. Taking into account the number of people who attempted to exercise their legal right of priority to acquire a piece of land on sale, the conclusion can be drawn that the issuance of a statement in urban areas is an unnecessary procedure.

The need to apply different regulatory measures of the agricultural land market in rural and urban areas as revealed and substantiated by the study can be applied in other countries, which seek to regulate the land market and to rationalize the use of land.

Conclusions and proposals

1. The rational use of land is one of the signs and indicators of the sustainable development. The real estate market has a significant impact on the economy, therefore the properly managed land market can stimulate the economic growth. However, the land market differs in different administrative areas and therefore the principles of regulation should be distinct.
2. Due to uneven urbanization in administrative areas of Lithuanian cities, a significant amount (about 15-20 percent) of agricultural land suitable for agricultural activities is situated on their outskirts. According to the territorial planning document solutions, these areas may be used for other activities, therefore it is financially difficult for farmers to compete in the acquisition of these land plots for agricultural purposes. A legal opportunity for farmers to acquire the adjacent land plot exercising the right of priority becomes unlikely because of the market characteristics.
3. It was determined that the legal regulation of the agricultural land market in Lithuania is already sufficient. Only a few scientific recommendations remained unimplemented. Taking into account different market conditions in urban and rural areas, it is reasonable to apply different regulatory measures for the land market, for instance, to reduce the requirements for persons willing to purchase
4. The research revealed that new regulatory “safeguards” for the land market do not impede the economic growth, because do not noticeably reduce the amount of the transferred land in urban areas. Also in view of the fact that people do not take advantage of their right of priority to acquire the transferred land, it can be stated that the NLS procedure carried out in an urban area also does not

cause any positive economic effect. If people willing to purchase the adjacent agricultural land plot in an urban area exercising their right of priority were subject to other requirements, it is likely that significantly more persons would exercise their right of priority, which would possibly result in the economic growth.

References

1. Aleknavičius M., Aleknavičius P. (2014). Žemės ūkio paskirties žemės rinkos raida. *Žemės ūkio mokslai*. Volume 21 (1), p. 23-36.
2. Aleknavičius P., Aleknavičius M., Tumelionis A. (2009). Privačios žemės ūkio paskirties žemės perleidimų priežastys ir tendencijos. *LŽŪU mokslo darbai*. Volume 84 (37), p. 46-54.
3. Aleknavičius P., Gaudėšius R. (2011). Klaipėdos miesto įtaka kaimiškųjų teritorijų žemės naudojimui. *Darnaus vystymosi strategija ir praktika*, Volume 5(1), p. 52-63.
4. Aleknavičius P. (2007). Kaimiškųjų teritorijų žemės naudojimo problemos. *Žemės ūkio mokslai.* Volume 14 (1), p. 82-90.
5. Cheshire P., Sheppard S. (2004). Land markets and land market regulation: progress towards understanding. *Regional Science and Urban Economics*, Volume 34, p. 619– 637.
6. Ciaian P., Kanes A., Swinnen J. and etc. (2012) Sales Market Regulations for Agricultural Land in EU Member States and Candidate Countries. *Faktor markets,* No. 14.
7. Čiegis R., Ramanauskienė J. (2011). Integruotas darnaus vystymosi vertinimas: Lietuvos atvejis. *Management theory and studies for rural business and infrastructure development*, Volume 26 (2).
8. Gaudėšius R., Aleknavičius P. (2015). Žemės ūkio paskirties žemės sklypų rinkos aktyvumas pagal sklypo savybes. *Žemės ūkio mokslai*. Volume 22(3), p. 163-172.
9. Gaudėšius R. (2014). Integrated development of rural areas to increase their competitiveness compared to urban areas. *Environmental research, engineering and management*, Volume 69 (3) p.60-69.
10. Girdzijauskas S., Mackevičius R. (2009). Kapitalo augimo modeliai ir logistinė kapitalo valdymo teorija. Naujas požiūris į ekonomines krizes. *Economic & management*. Volume 14, p. 757-762.
11. Kalenda Č. (2000). Ekologinė problema: turinys, esmė, ištakos. *Problemos,*Volume 58, p.42-54.
12. Lietuvos Respublikos žemės ūkio paskirties žemės įsigyjimo laikinojo įstatymo Nr. IX-1314 pakeitimo įstatymas 2014 m. balandžio 24 d. Nr. XII-854. TAR, 2014-04-29, Nr. 4860.
13. Lipski S.A. (2015). Private Ownership for Agricultural Lands: Advantages and Disadvantages (Experience of Two Decades). *Studies on Russian Economic Development*, 2015, Volume 26 (1), p.63–66.
14. Pažymos dėl parduodamos privačios žemės ūkio paskirties žemės išdavimo tvarkos aprašas, patvirtintas Nacionalinės žemės tarnybos prie Žemės ūkio ministerijos direktoriaus 2014 m. Sausio 10 d. Įsakymu Nr. 1P-(1.3.)-5. TAR, 2014-01-13, Nr. 161 "Dėl pažymos dėl parduodamos privačios žemės ūkio paskirties žemės išdavimo tvarkos aprašo patvirtinimo".
15. Pileckas M. (2004) Aplinkosauginių indikatorių taikymas Lietuvos Kraštovaizdžio monitoringui: būklė, problemos, perspektyvos. *Geografijos metraštis*, Volume 37 (1-2), p.112-122.

Information about author

Rimvydas Gaudėšius, is a PhD student studying at the Institute of Land Use Planning and Geomatics, Faculty of Water and Land Management, Aleksandras Stulginskis University, Lithuania. Research interest: sustainable development, land use planning and environmental engineering. Contact details: Universiteto str. 10, LT-53361, Akademija, Kaunas distr., Lithuania, Tel. + 370 37 752372 e-mail: Rimvydas.Gaudesius@asu.lt.

Virginija Gurskienė, doctor of technological science, assoc. prof., Institute of Land Use Planning and Geomatics, University of Aleksandras Stulginskis, Lithuania. Research interest: real property cadastre, planning of protected areas, urban planning. Contact details: Universiteto str. 10, LT-53361, Akademija, Kaunas distr., Lithuania, Tel. + 370 37 752272 e-mail: Virginija.Gurskiene@asu.lt.

Vida Maliene, PhD, is a Reader in Property and Planning studies at the Department of the Built Environment and an active member of the Built Environment and Sustainable Technologies (BEST) Research Institute, both at Liverpool John Moores University in the UK. Vida is a Visiting Professor at Institute of Land Use Planning and Geomatics in Aleksandras Stulginskis University, Lithuania. Her research focuses on Property and Planning including such related subjects as Spatial and Urban Planning, Urban Regeneration and Sustainable Communities, Land Management and Economics, Property Valuation and Taxation. Contact details: Department of the Built Environment, Liverpool John Moores University, Byrom street, Liverpool L3 3AF,United Kingdom; email:v.maliene@ljmu.ac.uk; Tel.: +44-(0)-151-231-2854.

LITHUANIAN LAND INFORMATION SYSTEM

Daiva Gudritienė
Aleksandras Stulginskis University, Kaunas Forestry and Environmental Engineering
University of Applied Sciences

Abstract
LIS is a convenient tool in the legal, administrative and economic decision-making process. The data of LIS includes: cartographic basis of spatial land datasets, thematic spatial land datasets and a variety of important information from the cadastre, registers and information systems. Lithuanian Land Information System is a developed and expanding field of information technology, which could be more used by the public users of Lithuania and other countries. The aim of this research is to determine the popularity of LIS services in Lithuania and promote a wider range of their usage possibilities among Lithuanian and foreign users. The object of the research is Lithuanian Land Information System. To achieve the aim the following objectives have been set out: to review the use of LIS in other countries; to describe the services that LIS offers and the data it compiles; to determine the popularity of LIS in Lithuania. In order to carry out the research the analysis of literary and cartographic material was used, a survey in writing was conducted. The data was processed with Microsoft Excel programme, the diagrams and informative pictures were presented. According to the research results, Land Information System helps to solve the problems of the land reform, planning, agriculture and rural development in countries of various development levels. The electronic services of LIS are provided for the receivers of LIS data in Lithuania free of charge, they are accessed through LIS map browser. The services are convenient and easy to use. After analysing the survey data, it can be stated that Land Information System is not very popular. It ranked the third place among all the presented information systems and obtained 9.5 percent of the respondent votes.
Key words: Land Information System, spatial data, LIS services

Introduction

In the EU countries the development of LIS receives a lot of attention and funds; thus Lithuania keeps up with other EU countries in the field of LIS development. It is important that LIS data can be obtained by natural and legal persons of the Republic of Lithuania and foreign countries as well as other foreign organisations, which use the LIS data and the electronic services of LIS. Therefore, a large part of services is publicly accessible to the farmers, students and other public users. They can use the information of the collections of the spatial data, perform a review of the statistical data, create and download various maps. It can be done free of charge. After learning to use the LIS services, students can use them for the practical, course and final works. A good knowledge of LIS services helps the specialists of many fields in professional and practical activity. When analysing the literature and monitoring the situation, the author noticed that many users do not know how they could use the public services of LIS. Therefore, this information must be publicised and shared.

The aim of the research – to determine the popularity of LIS services in Lithuania and promote a wide range of their usage possibilities among Lithuanian and foreign users.
To achieve the aim the following objectives have been set out:

- to review the use of LIS in other countries;
- to describe the services that LIS offers and the data it compiles;
- to determine the popularity of LIS in Lithuania.

Methodology of the research and materials

The object of the research – Lithuanian Land Information System. The article discusses publicly provided services for the unregistered or registered users. To carry out the research the analysis of literary and cartographic material was used, a survey in writing was conducted. A survey on popularity of publicly available internet access in Lithuania was carried out in 2015. 50 respondents were interviewed. The most famous information systems of land resources were listed in the survey. The data was processed with Microsoft Excel programme, the diagrams and informative pictures were presented.

Results and discussion

In 1660, Denmark presented a data system, which began to perceive the plot of land as the basic spatial unit. Later on, the term "cadastre" came into use in Austria. In 1970, the term "Land lnformation System" (LIS) was introduced. It combines and replaces all the terms used before (Vainauskas, 2012).

The data of LIS is compiled, renewed, grouped, its accessibility to the users is constantly growing. The basis of LIS is the unified spatial system binding the data suppliers and receivers. (Ciparisse, 2003).

LIS is a convenient tool in the legal, administrative and economic decision-making process. This system helps to solve the problems of the land reform, planning, agriculture and rural development. LIS enables data comparison, analysis, helps to make design solutions in the United Kingdom, North America and other developed countries. The wide use of LIS reveals the importance of the information compilation and search in order to improve the decision-making capacities and quality (Sounders, Cufler, 1993). In the developing countries LIS is also gradually recognised and installed, starting with the long legal process, social-economic reforms, which create the adequate official environment for the development of LIS (Sounders, Cufler, 1993). For example, since 2012 Mongolia has been developing the system of structured cadastre data collections with the "Multi" user access to the data collections in order to avoid data duplication in different organisations and adapt to the international standards in the field of LIS. The aim of the specialists is to create the land evaluation methodology operating on the basis of LIS. (Tuul, 2012). The above-mentioned information from various sources proves the importance of LIS in the countries of various development levels, its significance in the contemporary world.

The services of LIS can be defined as activities remotely provided for the service receivers by the system with the help of information measures (LIS…, 2011).

The electronic services of LIS are provided for the receivers of LIS data free of charge, they are accessed through LIS map browser which can be accessed through http://zis.lt/ or http://www.geoportal.lt/map/ adding „the services of LIS" (Fig. 1). The services are constantly developed and the provided information is updated.

After accessing the LIS map browser, the tools for the work with maps can be seen on the left side of the screen. There are 7 tools on the toolbar (Fig. 1) and the author describes them in the order according to their number in the picture.

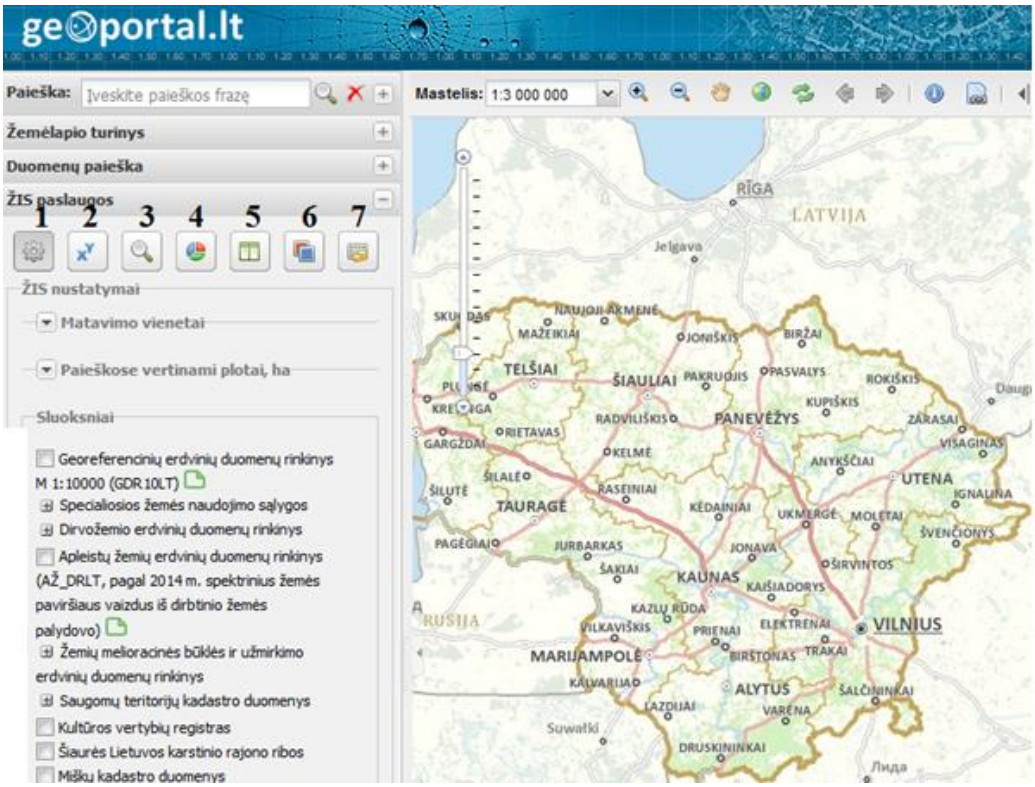


Fig. 1. LIS map browser with the toolbar

Explanations: paieška – research; mastelis – scale; žemėlapio turinys – the content of a map; duomenų paieška – the data research; ŽIS paslaugos – the services of LIS; ŽIS nustatymai – the settings of LIS; matavimo vienetai – measurement units; paieškose vertinami plotai, ha – the areas evaluated in researches, ha; sluoksniai – layers

1. LIS settings. It is a tool which is activated in the system, it enables to see the list of the data collections, the option lines of the units of measurement and the areas estimated in the searches. In the section "Units of measurement" the units of area and length can be set. In the section "Areas estimated in the searches", if the task requires it, an area interval is indicated according to the units of measurement chosen above.
Through the section "Layers", the layers, which are presented in the map browser, can be activated. The active layers can be controlled and deactivated in the line "Map content". Here the layers and their separate elements can be activated and deactivated, there is a button next to every layer which, after pressing it, allows performing more actions with the corresponding layer: to see the legend, to set the transparency to the layer, etc.
2. Object search according to their coordinates. This function allows carrying out the search of the spatial objects position with the set X and Y coordinates. The coordinates can be set manually by clicking the left button of the mouse on the data setting square. The set coordinates are shown in the map as dots, lines or areas upon the user's request after choosing one of the drawing tools.
3. Object search according to the area. This service allows carrying out a search of the area spatial objects around the earth according to the set area interval. It is really convenient when the location data of the specific municipality or the cadastre needs to be analysed.
From the presented list the requested collection of the spatial data, where the search is chosen to be carried out, is indicated, the type of the area objects, of which the search will be carried out, is indicated. The desired place is also indicated, i.e. the municipality, the cadastre location are chosen. The search area could be indicated pressing the button "Indicate the territory on the map". The button "Search" enables the function. The obtained results can be printed out and saved with the help of the corresponding buttons.
4. Statistics of the indicated objects. Analysis of the spatial data about the land in the indicated territory is conducted. Analysis results present statistical data of the indicated objects, such as total amount, total area, total length, etc. The function is enabled by pressing the button "Statistics of the indicated objects". From the list menu one shall select the spatial data set where statistics is to be calculated and indicate the type of objects for statistical calculation. The function is enabled by pressing the button "Calculate statistics". Result field presents the search results, the object description, total amount and area. There is an option to see the graphic expression of the data. By pressing the button "Depict objects graphically", a PDF file with graphically depicted objects is generated.
5. Map comparison. With the help of this service, a comparison of different maps is carried out in two equal-sized map windows. The service is called up by pressing the button "Map comparison". The map comparison is carried out on a vertically half-split desktop. The service is convenient to compare the different data of the same area, it can also be used to either review the area or to carry out an analysis.
6. Search of scanned plans. The service is provided in various criteria (in administrative boundary, specified scope, plan name) and the search of scanned and geographically oriented (binded) reclamation plans or cameralistic land productivity evaluation plans is carried out. The service is called up by pressing the button "Plan search". On the list you can select one of two options: project-based scanned land reclamation material, or cameralistic land productivity evaluation plans. After ticking, the layer is turned on, and the wanted plans will be displayed on a map. The plan can be searched by administrative boundary and you can specify the scope in which the search should be conducted. After specifying the wanted search criteria, the plan search can be carried out by the button "Search". The name of the found plan is provided in a result box. Plan download links are displayed in a column.
7. Rent and sale of land and forests. This is a service of the search of the rent and sale of land and forests published now or previously on auctions is carried out. This is a kind of the service when in a specified area the search of rent and sale of land and forests published now or previously on plot auctions, is carried out. There is the possibility to conduct a search according to various criteria: the type of land use, the type of auction, the auction status. The service is called up by pressing the button

"Rent and sale of land and forests". Before starting the work, a layer of rent and sale plots has to be turned on. In areas of search, purpose and type, the criteria of plot search and auction status are indicated. Then while choosing the area, the data is indicated: the entire territory of Lithuania or a specific municipality. After taping in the criteria, you can search for plots with the help of the button "Search". Any found plot that is in a result table will be displayed on the map (highlighted in red) by pressing the mouse. In order to use LIS services, it is necessary to review basic spatial datasets, which are presented to public users. Figure 2 presents the basic spatial datasets, which are assigned with capital letters, according to which the short name of a dataset will be presented. Spatial datasets on land are being generated using the Lithuanian coordinate system of 1994, which is approved by the Government of the Republic of Lithuania on 30 September, 1994.

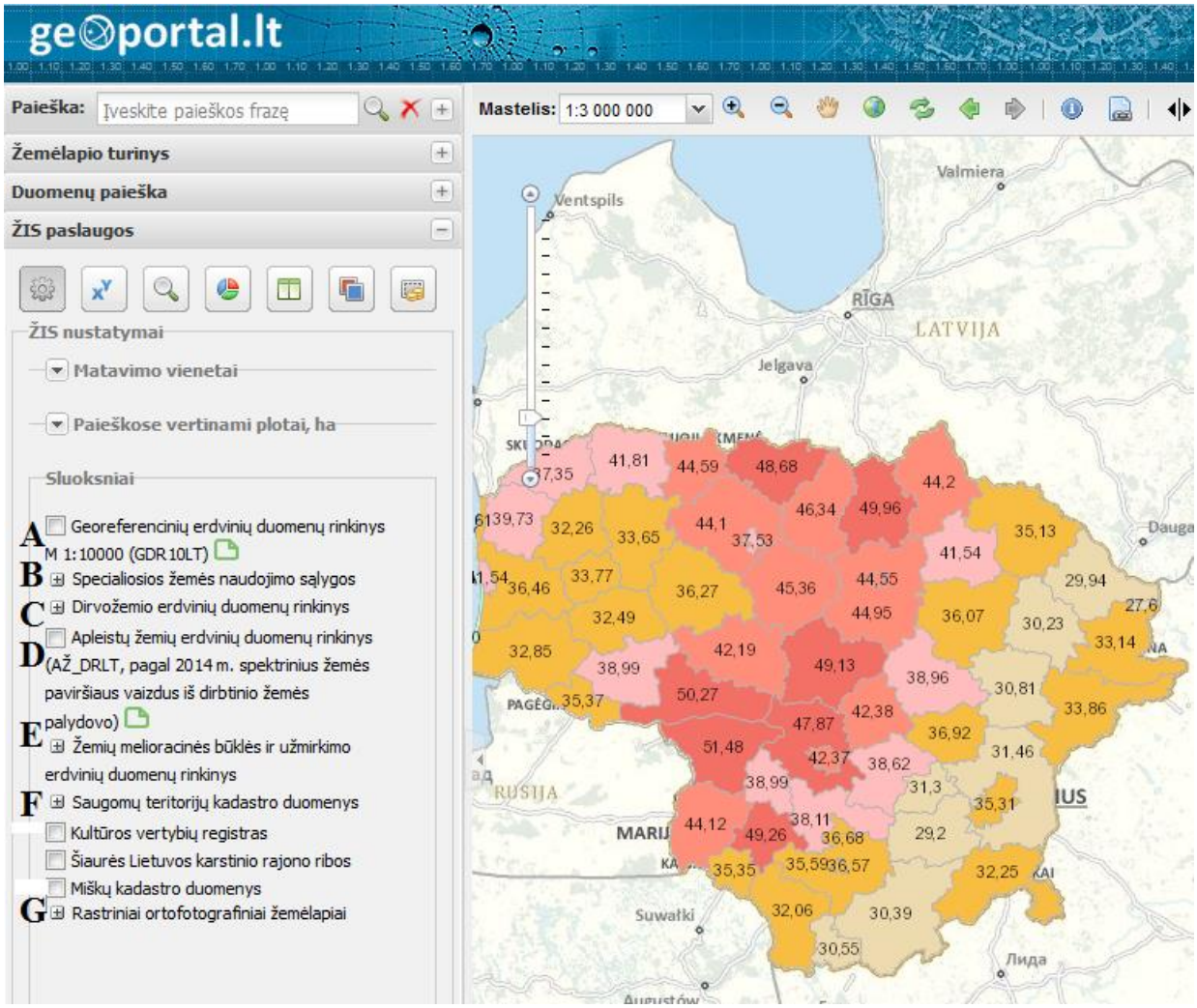


Fig. 2. Spatial datasets on land are presented on layers

Explanations: paieška – research; mastelis – scale; žemėlapio turinys – the content of a map; duomenų paieška – the data research; ŽIS paslaugos – the services of LIS; ŽIS nustatymai – the settings of LIS; matavimo vienetai – measurement units; paieškose vertinami plotai, ha – the areas evaluated in researches, ha; sluoksniai – layers

The cartographic base of spatial datasets on land consists of the following: a digital raster orthophotographic map ORT10LT (G) of the Republic of Lithuania 1: 10,000 and the data of geo-referencial basis cadastre GDR10LT (A)

A) The data of geo-referencial basis cadastre consists of three-dimensional objects related to water bodies, land cover, transportation network, engineering communications, geodetic points, heights, place names, etc (Kryžiauskas, Motiejauskas, 2010, Gudritienė, Abalikštienė, 2015).

G) Lithuanian digital orthophotographic map covers the entire territory of Lithuania. It is created on the basis of aerial photography. The data consists of several packages. One monocrhome raster data package in the period of 1995-1999 and three polychrome raster data packages in the period of 2005-2006, 2009-2010, and 2012-2013. The production work of a new orthophotographic map is currently in process (GIS..., 2015). The thematic spatial datasets on land consist of the graphic (vector) data of objects, their identification codes and descriptive information, both quantitative and qualitative indicators. National thematic spatial datasets are as follow:

1. The soil dataset Dirv_DR10LT of the Republic of Lithuania 1: 10,000;
2. The dataset Mel_DB10LT of reclamation condition and drench of Lithuanian land 1: 10,000;
3. The dataset SŽNS_DB10LT of special land use contitions of the Republic of Lithuania 1: 10,000.

B) The dataset SŽNS_DB10LT of special land use conditions of the Republic of Lithuania stores the information about the objects to which the Government of the Republic of Lithuania on 12 May, 1992 by resolution No. 343 "On the Approval of Special Conditions for the Exploitation of Land and Forest" the special conditions for the explotation of land and forest were established (ŽIS..., 2015).

C) The soil dataset Dirv_DR10LT of the Republic of Lithuania 1: 10,000 is constituted under a Lithuanian soil classification and Lithuanian soil typological units of the general sturctural list, in which the data on Lithuanian soil positioning, their physical and agrochemical qualities and other characteristics is systemised and coded (ŽIS…, 2015). The dataset structure is as follows: soil types, the predominant composition of the surface texture by Fere, the predominant composition of the pedogenetic texture by Fere, a soil productivity score.

D) The dataset AŽ_DB10LT of abandoned lands of the Republic of Lithuania, which contains information about unattended, unexploited, or unusable under the established basic land use of the landed property (ŽIS…, 2015).

E) The information about drained (good and poor reclamation condition) areas of land, discarded areas of well drained land, and non-drained areas of land is stored in the dataset Mel_DB10LT of reclamation condition and drench of Lithuanian land (ŽIS…, 2015).

F) The data of cadastre, register, and information systems contains a lot of important information.

The column introduces the data from the following:

- The cadastre of the Republic of Lithuania of protected areas
- The cultural heritage register
- The underground register
- The information systems of state geology.

Most of the respondents are young, aged from 16 to 30 years old, they represented 78.6 of the total number of respondents. It is very good, because this group of respondents regularly use the achievements of information technology (Fig. 3).

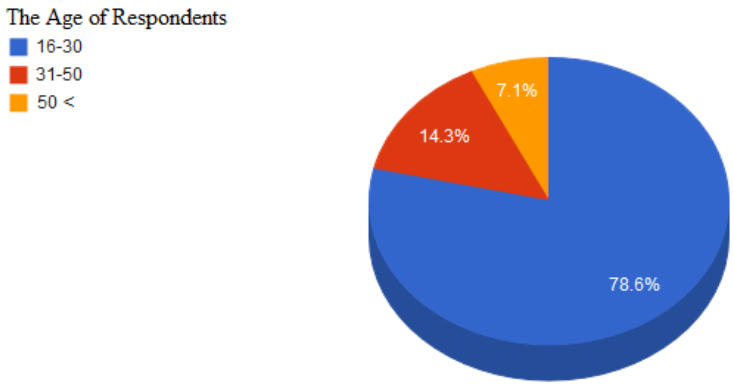


Fig. 3. Age of respondents

9 public internet access points, among which zis.lt was mentioned in the first place, were introduced (Fig. 4).

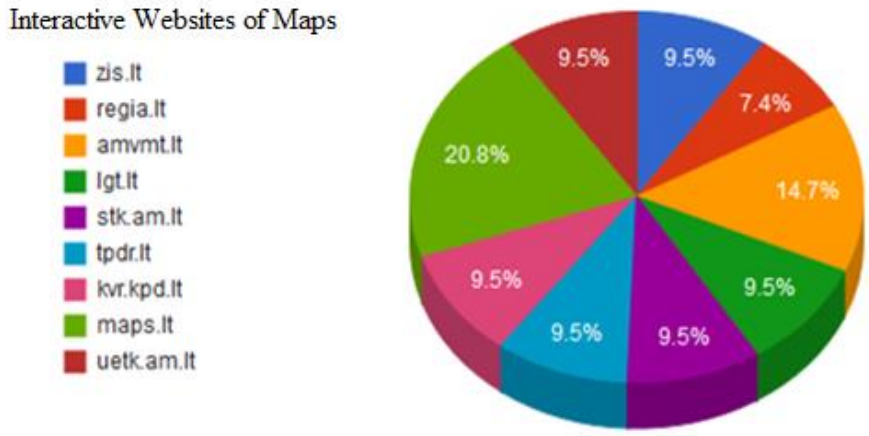


Fig. 4. Precentage of the popularity of public internet access

According to the results of the survey, it can be said that the most in-demand internet site is an interactive map website (maps.lt), it obtained 20.8 percent of the votes of respondents. The Land Information System (zis.lt) and underground register (lgt.lt) are in third place, as both obtained 9.5 percent of the votes of respondents. Although the survey was attended by plenty of young people, the results suggest that the Land Information System is not very popular, so it can be said that there is the lack of popularity of this data.

Summarising the results, it can be said that the Land Information System is a developed and still developing area of information technology, which could be more widely used by both Lithuanian and other countries' public users.

One of the tasks of the reasearch is to publicise and popularise the Lithuanian Land Information System, so that more public users could benefit from it.

Conclusions

1. The LIS helps to solve land reform, planning, agriculture and rural development problems in countries of various levels of development.
2. LIS recipients in Lithuania are provided with free of charge LIS electronic services, they are convenient and easy to use and can be accessed on LIS map browser.
3. LIS data consists of the following: the cartographic basis of spatial datasets on land; the thematic spatial datasets on land, and a lot of important information for cadastre, register, and information systems.
4. An analysis of the survey data suggests that the LIS is not very popular, among all the provided information systems, it occupied third place and obtained 9.5 percent of the votes of respondents.
5. The Lithuanian LIS is a developed and still developing area of information technology, which could be more widely used by both Lithuanian and other countries‘ public users.

References

1. Ciparisse G. (2003). Multilingual thesaurus on land tenure. Land Information Systems: services and tools of public land administration ISBN 92-5-104283-7, 81-96 p. Interactive, Accessed in 2015–10–03 (ftp://ftp.fao.org/docrep/fao/005/x2038E/x2038E00.pdf).
2. Dėl Žemės informacinės sistemos nuostatų ir Žemės informacinės sistemos duomenų saugos nuostatų patvirtinimo (2014). Interactive, Accessed in 2015–03–15 (https://www.e-tar.lt/portal/lt/legalAct/bd4058f04f0111e49cf986e1802f1de9).
3. GIS-centras (2015). Interactive, Accessed in 2015–08–25 (http://www.gis-centras.lt/gisweb/index.php?pageid=330).
4. Gudritienė D., Abalikštienė E. (2015). Rsearch of the reliability of georeferential spatial dataset (GDR10LT) of the republic of Lithuania. *Baltic surveying 15*. ISSN 2255-999X. vol. 1, p.35–39.

5. Kryžiauskas A., Motiejauskas D. (2010). Automatizuotas hidrografijos kanalų išskyrimas Lietuvos georeferencinio pagrindo duomenų bazėje. *Geodezija ir kartografija*. Interactive, Accessed in 2014-03-15 (www.tandfonline.com/doi/abs/10.3846/gc.2010.18#.U3Isq3lZrIV).
6. Lietuvos erdvinės informacijos portalas (2015). Interactive, Accessed in 2015–08–25 (www.geoportal.lt).
7. Papišienė L. (2014) Georeferenciniai duomenys. Interactive, Accessed in 2015–08–10 (http://www.gis-centras.lt/gisweb/index.php?pageid=8).
8. Sounders J., Cufler J., (1993). Land Information Systems Saunders Interactive, Accessed in 2015–10–03 (http://www.gisl.co.uk/lis.htm).
9. Tuul B. (2012). Land Information Systems. GIS based Land Information System for mandalsoum, selengeaimag of Mongolia. Interactive, Accessed in 2015–10–03 (http://www.gisl.co.uk/lis.htmhttp://www.isprs.org/proceedings/XXXVIII/part6/papers/Batbaldan/full_paper.pdf).
10. Vainauskas V. (1994). Geodezijos darbai. Žemės informacinės sistemos. Interactive, Accessed in 2015–02–15 (http://www.tandfonline.com/doi/pdf/10.1080/13921843.1994.10552725).
11. Žemės informacinė sistema (2015). Interactive, Accessed in 2015-09-10 (http://zis.lt/duomenys/).
12. Žemės informacinės sistemos nuostatai (2011). Interactive, Accessed in 2015-09-15 (https://www.e-tar.lt/portal/lt/legalAct/TAR.0B88D61F5B92).

Information about author
Daiva Gudritienė. Lecturer, Institute of Land Management and Geomatics, Faculty of Water and Land Management, Aleksandras Stulginskis University. Address: Universiteto 10, LT-53361, Akademija, Kaunas r., Lithuania, Tel. + 370 37 752372. Lecturer, Faculty of Environmental Engineering, Kaunas Forestry and Environmental Engineering University of Applied Sciences. Address: Liepų g. 1, Girionys, LT 53101, Kauno r., Lithuania, Tel.. +370 37 383082 e-mail: gudritiene@gmail.com.

ANALYSIS OF THE CHANGE IN LITHUANIAN ORGANIC FARMING

Giedrė Ivavičiūtė[1, 2, 3], **Juozas Ūselis**[1]
[1]Aleksandras Stulginskis University, [2]Kaunas Forestry and Environmental Engineering University of Applied Sciences, [3]Klaipeda State University of Applied Sciences

Abstract
The article contains information about the change in the country's landed property and areas occupied by farmers as well as the analysis of the change in organic farms and their areas in the Republic of Lithuania within the period from 2010 to 2014. The maximum and minimum areas of organic farming in municipalities as well as their change were determined for the detailed analysis.
Comparative, analytical as well as statistical and logical analysis methods were used for the investigation.
The aim of the investigation – to analyse the number of organic farms and the change in their occupied areas and to identify the reasons.
The object of the investigation – Lithuanian organic farms.
The analysis showed that in Lithuania within the period from 2010 to 2014 the number of organic farms decreased by 171, or by 6.53 percent. The largest number of organic farms was determined in Biržai, Ukmergė and Raseiniai district municipalities, the lowest – in Druskininkai, Rietavas and Kalvarija municipalities. Within the period from 2010 to 2014, the area of organic farming in Lithuania increased by 20481.65 hectares or by 12,45 percent. Out of 50 municipalities of the Republic of Lithuania, the areas of organic farming increased in 46 municipalities of the country, while the decrease in the areas of organic farming was observed in the six municipalities: Kėdainiai distr. (20.84 percent), Pakruojis distr. (16.45 percent), Pasvalys distr. municipality (40.16 percent), Šakiai (25.94 percent), Šiauliai (17.62 percent), Vilkaviškis (44.35 percent).
***Key words*:** organic farming, agricultural lands, certified organic farms.

Introduction

Because of the climate change and the negative impact of human activities on the environment, the restoration and conservation of agriculture-related ecosystem, soil erosion prevention and quality improvement are relevant and important topics.
Agriculture has changed. Food and fiber productivity soared due to new technologies, mechanization, increased chemical use, specialization and government policies that favored maximizing production. Although these changes have had many positive effects and redused many risks in farming, there have also been significant costs (Vellidis, Gattie, Smith, 2009).
Organic farming is an alternative activity to solve negative issues of the globalization process (Skulskis, Kairytė, Zemeckis, 2006). Thus, such farming is one of the measures implementing the sustainable farming goals, which are safe for the environment and the people.
Organic farming is important because conventional agriculture - which involves high-yielding plants, mechanized tillage, synthetic fertilizers and biocides - is so detrimental to the environment (Ivavičiūtė, 2014).
The aims of organic farming are to protect: the environment, by using organic management practices that do not have the adverse effects of conventional practices, and the health of consumers, by the provision of organic products (Argyropoulos et. al., 2013).
J. Čiulevičius, J. Kirstukas and R. Kripaitis (2007) define organic farming as a farm, where agricultural production meets all the existing environmental requirements. It is a farm that avoids using synthetic chemical fertilizers and pesticides: the plant demand for nutrients is met from natural organic sources, and the fight against disease and pests is carried out using natural organic materials and methods.
Organic farming in Europe has been developed since ancient times, however, in Lithuania it was launched only from 1990. For a decade several enthusiasts supported the idea of organic farming, and from 2000, after the state began to subsidize organic production, the attention increased in this trend of farming (Ekoagros, 2014).
Lithuanian scientists (I. Zableckis, R. Zemeckis, A. Dautartė, J. Pekarskas) conducted a study that evaluated the influence of the eligibility criteria and requirements for the support on the implementation of the program. During the study, the application of a mapping method enabled to determine distribution of applicants for agri-environment benefits in question as well as their declared landed property and crop in different areas of the country, and it was found that the highest concentrations of organic farms appear in less favoured areas, which are dominated by specialized

grain production. Since such a trend does not meet the principles of organic farming, it was suggested to promote the development of mixed farms in the future (FPP Consulting, 2014).
Organic farming in the EU is a system of agriculture and food production that combines favourable environmental and animal welfare standards and is supported by EU law (Regulations (EC) No 834/2007 and 889/2008/EC) (EUFIC Review, 2013).
EU and national government policies as well as their role in the development of organic farming are very important, i. e. public policy and financial support is regarded as one of the most important factors in promoting organic farms and their development (Skulskis, Stankaitytė, Daunytė, 2011). Continuing the Rural Development Programme for 2007-2013 "Organic Farming", rules on the implementation of the Lithuanian Rural Development Programme 2014-2020 measure "Organic Farming" were also approved (Lithuania ..., 2015).
However, I. Kriščiukaitienė and V. Namiotko (2013) pointed out that in Lithuania the problem arises from the fact that compensatory amounts are insufficient incentives to develop livestock farming and horticulture, to develop organic production throughout the farm and to increase the volume of organic production.
Researchers note that organic farming is fundamentally different from the traditional one (Padel, 2008), which is caused not only by differences in the quality of food, but also by different effects on the natural environment.
Sustainable development in agriculture – is an organic farming helping solve important problems in rural areas (Brazauskienė, 2002).
Most of the studies that compared biodiversity in organic and conventional farming demonstrated lower environmental impacts from organic farming. The key challenges in conventional farming are to improve soil quality (by versatile crop rotations and additions of organic material), recycle nutrients and enhance and protect biodiversity. In organic farming, the main challenges are to improve the nutrient management and increase yields. In order to reduce the environmental impacts of farming in Europe, research efforts and policies should be targeted to developing farming systems that produce high yields with low negative environmental impacts drawing on techniques from both organic and conventional systems (Tuomisto et. al., 2012).
Organic farming allows to practice old, environmentally friendly farming traditions, maintaining rural social structure and genuine agrarian landscape. The benefits of organic farming are obvious.
The object of the investigation – organic farms certified in Lithuania.
The aim of the investigation. To perform the change analysis of Lithuanian organic farms within the period form 2010 to 2014.
Tasks of the investigation:
1. To analyze the change in the landed property and declared farms within the period form 2010 to 2014.
2. To conduct the change analysis of Lithuanian organic farms and their areas.

Methodology of research and materials
Comparative, analytical as well as statistical and logical analysis methods were used for the investigation.
For the performance of the analysis, scientific articles, laws of the European Union and the Republic of Lithuania were examined. Significant benefits of organic farming for the environment, biodiversity, etc. were determined.
To fulfill the tasks set, the methods of data analysis, synthesis, comparison, graphing representation, data clustering were applied.
The analysis is based on the statistical data and information provided by Public Institution "Ekoagros", which are grouped in the article, compared and analysed on the national scale of the Republic of Lithuania and in individual municipalities. The mathematical calculations and their percentage expressions enabled to determine the change in the Lithuanian organic farms and its reasons.

Discussion and results
The analysis of the landed property and declared farms. Agricultural activities and environmental protection are inextricably linked. Agriculture is important for preserving the natural resources and agrarian landscape.
In 2014 the landed property occupied 3461942,22 ha, i. e. more than half of the territory of Lithuania (53 percent), agriculture-purpose area occupied 3941801,54 or 60,38 percent of the country area. In comparison with 2010, in 2014 the agricultural land area decreased by 12317,15 ha or 3,12 percent.

In the family farm register of Lithuania, 107308 family farms were registered in 2010, which occupied the area of 1040909,95 ha (26,32 percent of agricultural land). In 2014, the number of farmers in the register was 117457, and the total area of the used land comprised 1127039,15 ha. The comparison of the data of 2010 and 2014 reveals that within the four-year period the number of farmers increased by 10149, or 8,64 percent, and the used area – by 86129,20 ha or 7,64 percent.
In 2010 the declared landed property occupied 2053546,52 ha, while in 2014 – 2359467,84 ha, i. e. the area of the declared landed property of family farms increased by 305921,32 ha or 12,97 percent. The average area of the landed property per farm was 19,14 ha in 2010, and 20,09 ha in 2014.
It is important for the state to maintain the traditional landscape depending on farming, biodiversity, environmental cleanliness and nutrient balance needed for people to lead a healthy lifestyle and for the wildlife to thrive. Therefore it is necessary to encourage farmers to farm sustainably, to seek high quality in agriculture and livestock farms, to maintain healthy environment while expanding the area of organic farming.
However, since 2011 the number of organic farms was decreasing every year. During the period from 2010 to 2014, the number fell by 171, or 6,53 percent (Fig. 1).

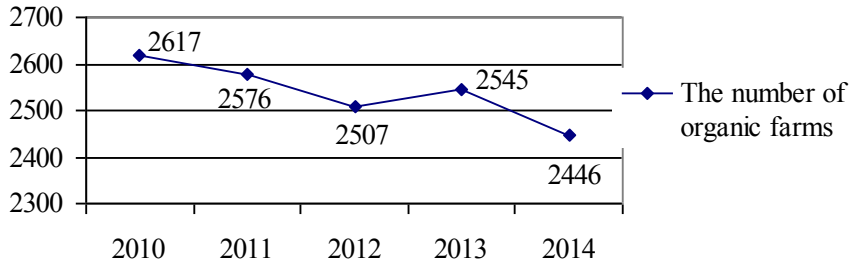


Fig. 1 Changes in the number of organic farms within the period form 2010 to 2014

The largest number of organic farms in 2010 was determined in Biržai district municipality (162 farms, or 6,19 percent of the total number of organic farms), Ukmergė district (140 farms or 5,35 per cent) and Raseiniai district (125 farms or 4,78 percent) municipalities. The least organic farms was in Druskininkai (7 farms), Rietavas (7 farms) and Kalvarija (9 farms) municipalities (Fig. 2).
In 2014 the largest number of organic farms was also determined in Biržai, Raseiniai and Ukmergė district municipalities. However, in Biržai distr. municipality the number of farmers fell by 23 farms (14,20 percent), in Ukmergė distr. - by 12 (8,57 percent), in Raseiniai distr. – by 40 (32 percent).
In 2014, just like in 2010, the least organic farms were in Druskininkai, Reitavas and Kalvarija municipalities, however, their number slightly increased: in Druskininkai and Kalvarija municipalities – by one organic farm, and in Rietavas - by three farms (Fig. 3).
The analysis revealed that more organic farmers are in the northern, eastern and western parts of the country and in less favoured areas. The number of organic farms fell due to violations of "The Rules of Organic Agriculture" identified during the inspection and non-compliance with organic farming requirements, which resulted in the cancellation of certificates.

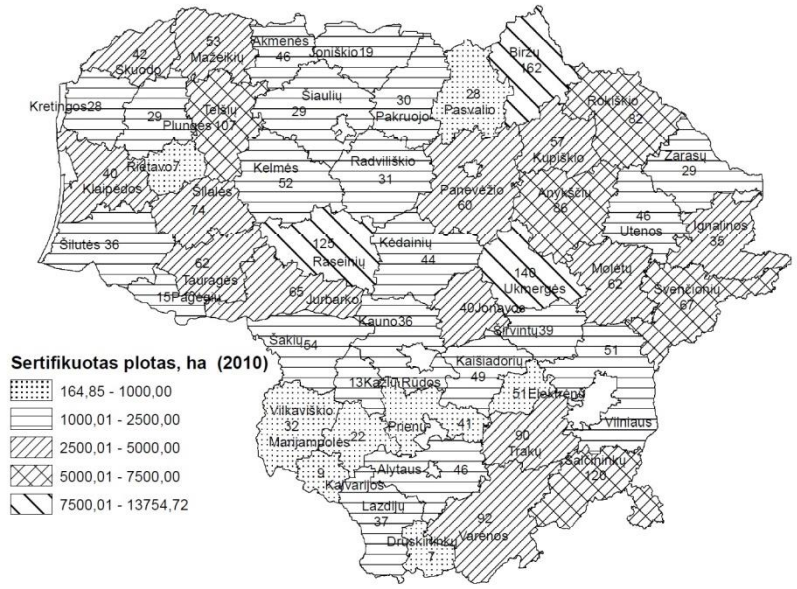


Fig. 2. Distribution of areas and numbers of certified organic farms in Lithuanian municipalities in 2010

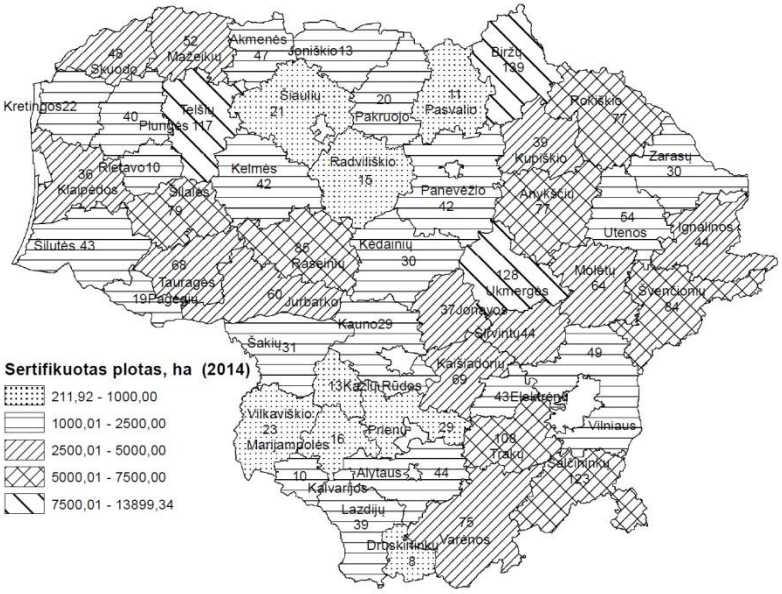


Fig. 3. Distribution of areas and numbers of certified organic farms in Lithuanian municipalities in 2014

In Lithuania organic farming areas are increasing. In 2010, organic farms comprised 4,16 percent of the country's landed property area and occupied 144006,23 ha. In 2014, after the increase in the area of organic farming, they comprised 4,75 percent of the total cultivated land. Although the above analysis shows that the number of organic farms is decreasing, however, the area of certified organic production is growing. During the period from 2010 to 2014, the area of organic farming in Lithuania increased by 20481.65 ha or 12.45 percent (Fig. 4).

It was determined that the average area of a certified organic farm in 2010 was 55.03 ha, and in 2014 – 67.25 ha, while the average landed property per farm in Lithuania in 2010 was 19.14 ha, and in 2014 – 20.09 ha. The analysis shows that the average area of organic farms is three times higher in comparison with average Lithuanian farm size.

The analysis of the change in areas of organic farms in Lithuanian municipalities within the period from 2010 to 2014 reveals that in 2010 the largest areas were in Biržai district municipality (13754,72 ha), i. e. 14.46 percent of the total municipal landed property, or 18.99 percent of utilized landed property area of the declared family farms. In Biržai district the area of an average organic farm comprised 84.91 ha. Within the period 2010-2014 the area of organic farms in the district municipality

increased by 144.62 ha or 1.04 percent, which occupied 13899.34 ha and comprised 14.62 percent of the municipal landed property, or 17.68 percent of utilized landed property area of the declared family farms. In 2014 the average area of an organic farm in Biržai district municipality was 100 ha. It was found that the number of organic farms in Biržai district municipality decreased in four years, however, the area – increased.

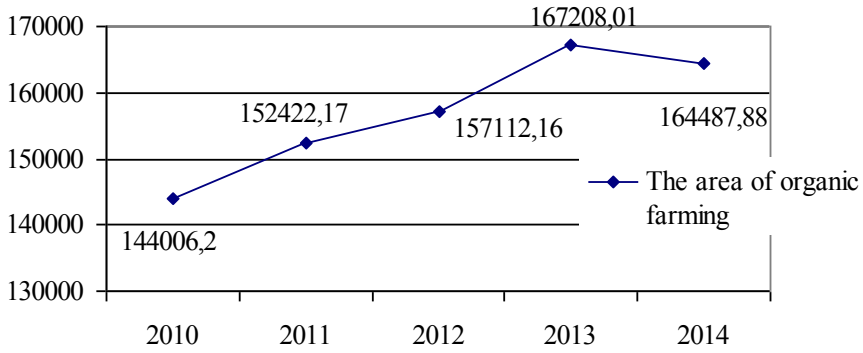


Fig. 4 Changes in the area of organic farming within the period form 2010 to 2014 in ha

In Ukmergė district municipality within the period from 2010 to 2014 the area of organic farms also increases by 931.96 ha or 9.35 percent. In 2010 farms under investigation occupied 9037.43 ha and comprised 12 percent of the total municipal landed property, or 19.68 percent of utilized landed property area of the declared family farms. The average area of a farm was 64,55 ha. In 2014 organic farms occupied 9969.39 ha, i. e. 13.24 percent of the total municipal landed property, or 18.51 percent of utilized landed property area of the declared family farms. In 2014 the average area of an organic farm was 77.89 ha. In Ukmergė district municipality, similarly to Biržai disrt. mun., the number of organic farms decreased, however, the area – increased.

In 2010 in Raseiniai district municipality organic farms occupied 6642.96 ha and comprised 6.6 of the total municipal landed property, or 9,21 percent of utilized landed property area of the declared family farms. The average area of a farm in 2010 was 53.14 ha. Within the period 2010-2014 the number of organic farms in the municipality increased by 576.97 ha or 7.99 percent and occupied the area of 7219.93 ha, which comprised 7.18 of the total municipal landed property, or 9.20 percent of utilized landed property area of the declared family farms. In 2014 the average area of farms in question was 84.94 ha. Thus the research reveals that within the period 2010-2014 the number of organic farms decreased by 40, however, the area increased by 8 percent in Raseiniai district municipality.

The analysis of the change in organic farming areas within the period 2010-2014 revealed that the areas of organic farming decreased in six municipalities out of 60 municipalities of the Republic of Lithuania: in Kėdainiai distr. municipality the area of organic farming dropped by 503.82 ha or 20.84 percent. In Pakruojis distr. municipality the area decreased by 214.94 ha or 16.45 percent, in Pasvalys distr. mun. – by 366.76 ha (40,16 percent), in Šakiai distr. mun. – by 561.4 ha or 25.94 percent, in Šiauliai distr. mun. – by 200.53 ha (17,62 percent), in Vilkaviškis distr. mun. – by 378.47 ha or 44.35 percent. In Lithuania the largest area of organic farming decreased within the period 2010-2014 was determined in distr. mun. (561.4 ha).

It should be noted that within the period 2010-2014 areas of organic farming increasing in 46 municipalities of the state, the development occurred because of the end of transitional period and the validation of certified organic farm areas.

In Lithuania, organic farming is becoming increasingly popular. Their development results in the reduction of environmental pollution, preservation of biodiversity, with the aim to at least partially reduce poor soil areas, to ensure food safety, the improve landscapes which are relevant not only to the environment and living organisms, but can also provide greater socio-economic benefits. In the production process of organic farming, more work needs to be done manually, in contrast to the intensive production farming, therefore this kind of work requires more workers, which promotes the small farming and the employment of people in rural areas.

Conclusions

1. In 2014, the landed property in the Republic of Lithuania occupied 3461942.22 ha, i. e. more than half of the state area (53 percent), the agricultural land occupied 3941801.54 ha, or 60.38 percent of the total state area. Within the period from 2010 to 2014 the agricultural land decreased by 12317.15 ha, or 3.12 percent, however, the number of farmers over the period of four years increased by 10149, or 8.64 percent, and their occupied area increased by 86129.20 ha, or 7.64 percent. The declared landed property of family farms increased by 305921.32 ha, or 12.97 percent. An average area of landed property per farmer in 2010 comprised 19.14 ha, while in 2014 it was 20.09 ha.
2. In the period 2010-2014, the largest number of organic farms was determined in Biržai, Ukmergė and Raseiniai district municipalities, the lowest number of organic farms was found in Druskininkai, Rietavas and Kalvarija municipalities. In Lithuania within the period from 2010 to 2014 the number of organic farms decreased by 171 or 6.53 percent. The number of organic farms fell because of irregularities and non-compliance with the requirements of organic farming identified during inspection.
3. Within the period from 2010 to 2014 the area of organic farms in Lithuania increased by 20481.65 ha, or 12.45 percent. The average area of a certified organic farm in 2010 comprised 55.03 ha, and in 2014 it was 67.25 ha, while the average area of landed property per farmer in Lithuania in 2010 comprised 19.14 ha, and in 2014 it was 20.09 ha.
4. The analysis of the change in organic farming areas in Lithuanian municipalities within the period from 2010 to 2014 revealed that the largest area was situated in Biržai distr. municipality and increased by 144.62 ha, or 1.04 percent, and in 2014 it occupied the area of 13899.34 ha, the average area of an organic farm was 100 ha. In Ukmergė distr. municipality within the period from 2010 to 2014 the area of organic farms increased by 931.96 ha, or 9.35 percent, and in 2014 it occupied 9969.39 ha, the average area of an organic farm was 77.89 ha. In Raseiniai distr. municipality within the period from 2010 to 2014 the area of organic farms increased by 576.97 ha, or 8 percent, however, the number of organic farms decreased by 40.
5. The analysis of the change in organic farming areas within the period from 2010 to 2014 revealed that out of 50 municipalities of the Republic of Lithuania, the areas of organic farming decreased in 6 municipalities of the country: Kėdainiai distr. (503.82 ha, or 20.84 percent), Pakruojis distr. (214.94 ha, or 16.45 percent), Pasvalys distr. municipality (366.76 ha, or 40.16 percent), Šakiai (561.4 ha, or 25.94 percent), Šiauliai (200.53 ha, or 17.62 percent), Vilkaviškis (378.47 ha, or 44.35 percent). Within the period from 2010 to 2014 the areas of organic farming increased in 46 municipalities of the state, the development occurred because of the end of transitional period and the validation of certified organic farm areas.

References

1. Argyropoulos Ch, Tsiafouli M. A, Sgardelis S. P., Pantis J. D. (2013). Organic farming without organic products. *Land Use Policy,* Volume 32, p. 324-328.
2. Brazauskienė D. (2002). Ekologinė žemdirbystė – tausojanti plėtra žemės ūkyje [Organic Farming – Sustainable Development in the Agriculture]. *Žaliasis pasaulis*, 2002, rugsėjo 26 d.
3. Čiulevičius J., Kirstukas J., Kripaitis R. (2007). Tausojančio ūkininkavimo plėtojimo Šiaurės Lietuvos karstiniame regione ekonominės prielaidos. *Žemės ūkio mokslai,* Vilnius: LMA, 2007, Nr. 14, p. 3-5.
4. Ekoagros (2014). Ekologinis ūkininkavimas Lietuvoje. 2014. – 23 p.
5. EUFIC Review (2013). Organic food and farming: scientific facts and consumer perceptions. Viewed 1 April, 2016, (http://www.eufic.org/article/en/expid/Organic_food_and_farming_scientific_facts_and_consumer_perceptions/.
6. FPP Consulting (2014). Ekologinio ūkininkavimo ir kraštovaizdžio tvarkymo programų vertinimo galutinė ataskaita. 120 pp.
7. Ivavičiūtė G. (2014). Ecological farming in Aukstadvaris and Krekenava Regional Parks. *Research for Rural Development 2014. Annual 20th Internationals Scientific Conference Proceedings.* p. 133-139.
8. Kriščiukaitienė I., Namiotko V. (2013). Valstybės paramos žemės ūkio ekologinei gamybai veiksmingumo vertinimas. *Management Theory and Studies for Rural Business and Infrastructure Development.* Vol. 35. No. 3. Scientific Journal, p. 391-397.
9. Lietuvos Respublikos žemės ūkio ministro įsakymas „Dėl Lietuvos kaimo plėtros 2014 – 2020 metų programos priemonės „Ekologinis ūkininkavimas" įgyvendinimo taisyklių patvirtinimo" (2015 04 20 d. Nr. 3D-286). *Teisės aktų registras*, 2015 – 06028.
10. Nacionalinė žemės tarnyba prie Žemės ūkio ministerijos. *Lietuvos Respublikos žemės fondas.* (2014). Vilnius, 144 p.

11. Padel S. (2008). Values of organic producers converting at different times: results of a focus group study in five European countries. *Int. J. Agricultural Resources, Governance and Ecology*, Vol. 7, Nos. 1/2, p. 63–77.
12. Skulskis V., Kairytė E., Zemeckis R. (2006). Ekologinį ūkininkavimą skatinančių veiksnių vertinimas. *Žemės ūkio mokslai*. 2006, Nr. 1, p. 55-61.
13. Skulskis V., Stankaitytė B., Daunytė R. (2011). Paramos įtaka įvairių ūkininkavimo tipų ekologinių ūkių ekonominiams rezultatams. *Management theory and studies for rural business and infrastructure development.* Nr. 5 (29). Research papers, p. 201-210.
14. Tuomisto H.L., Hodge I.D., Riordan P., Macdonald D.W. (2012) Does organic farming reduce environmental impacts? A meta-analysis of European research. *Journal of Enviromental Management.* Volume 112, p. 309-320.
15. Vellidis G., Gattie D.K, Smith M.C. (2009). Ecology and Technology. *Agricultural Mechanization and Automation,* Vol. II, p.166.

Information about authors
GIEDRĖ IVAVIČIŪTĖ, Lecturer, Institute of Land Use Planning and Geomatics, Water and Land Management faculty, Aleksandras Stulginskis University. Address: Universiteto g. 10, LT – 53361 Akademija, Kauno raj., Lithuania. Tel. 8 – 37 75 23 72, e-mail: ivavice@gmail.com. Fields of interest: landscape architecture.
Lecturer, Kaunas Forestry and Environmental Engineering University of Applied Sciences. Address: Liepų st. 1, Girionys, LT -53101, Kauno raj. Lithuania. e-mail: ivavice@gmail.com.
Lecturer, Klaipeda State University of Applied Sciences. Address: Jaunystės st. 1, LT-91274, Klaipėda, Lithuania. e-mail: ivavice@gmail.com.
JUOZAS ŪSELIS, Assistant, Institute of Land Use Planning and Geomatics, Water and Land Management faculty, Aleksandras Stulginskis University. Address: Universiteto g. 10, LT – 53361 Akademija, Kauno raj., Lithuania. Tel. 8 – 37 75 23 72, e-mail: juozas_uselis@yahoo.com.

ANALYSIS OF THE INDICATORS OF THE CADASTRAL VALUE BASE FOR RESIDENTIAL BUILDING LAND IN LATVIA

Anda Jankava, Aina Palabinska, Dace Didrihsone
Latvia University of Agriculture

Abstract
This article describes the indicators of the base of cadastral value and their main influencing factors.
The base of cadastral value for residential building is summarised and analysed in Latvia municipalities and its territorial units in 2015. The analysis results showed areas with the highest and lowest base of cadastral value for residential building in municipalities of Latvia. Also grouping and analysis of municipalities by the maximum and minimum base of cadastral value for residential building land in rural areas were carried out. There is clear polarisation of base value by the distribution between the municipalities. In municipalities around Riga there are areas with the highest base value of residential building land, whereas the base value decreases rapidly in the direction from Riga to the periphery.
Key words: cadastral assessment, indicators of the cadastral value base, value zoning, base value.

Introduction

In Latvia, the cadastral valuation of real property is carried out in order to determine the cadastral value of the real property which is mainly used in the calculation of real property tax. In the need of cadastral valuation, the State Land Service drew up the cadastral value base by real property groups.. The cadastral value base is a set of data characterising the value necessary for calculation of the cadastral value – base values and correction coefficients, which, on the basis of analysis of data of the real estate market, has been specified for the group of cadastre objects in terms of values within a relatively homogenous territory – zone (National Real Estate ..., 2005.). The cadastral base value uses generally recognised real estate valuation standards of the assessment methods - transaction comparison method, income capitalisation method and cost method (Freibergs, Žuromskis, 2013). Until 2015, the cadastral value base was updated annually, but starting from 2015 the base of cadastral value is updated and approved by the Cabinet of Ministers every two years in order to ensure the immutability of the cadastral value in a longer period (Regulations regarding Cadastral ..., 2006).
The cadastral value base consists of two indicators – base values and correction coefficients, which are adjusted in the calculation of cadastral value of real property. In order to develop the cadastral value base, in Latvia, just like in other countries, the information about real property market is used toset real property market prices, rent prices and the price level of property prices (Adair, Downie, McGreal, Vos, 1996). For this purpose, in cadastral information system, the real property market database is maintained, in which information about the real property market transactions is stored and processed. It should be noted that the indicators of base of cadastral value are affected by the activity of the real property market. They vary in in different municipalities and territorial units of Latvia. Based on the above, the zoning of the value is being developed, there are defined zones of the value and their boundaries in which different indicators of cadastral value base, i.e. basic values and correction coefficients, are applied.
The aim of the article is to analyse one of the indicators of the base of cadastral value, namely,the base of value of individual residential building land (hereafter – residential building land) in rural areas.

Methodology of research and materials

Analysis of the land base value of individual residental building land (hereafter - the base value) i based on the base value of 2015 developed by State Land Service and approved by Cabinet of Ministers. The base values were developed for every municipal territorial units of Latvia.
In Latvia there are 110 municipalities, which consist of one or more territorial units of municipality rural territories and municipality towns, which are set in five planning regions - Kurzeme, Zemgale, Vidzeme, Latgale and Riga (Fig.1), (Law on Administrative Territories .... 2008).

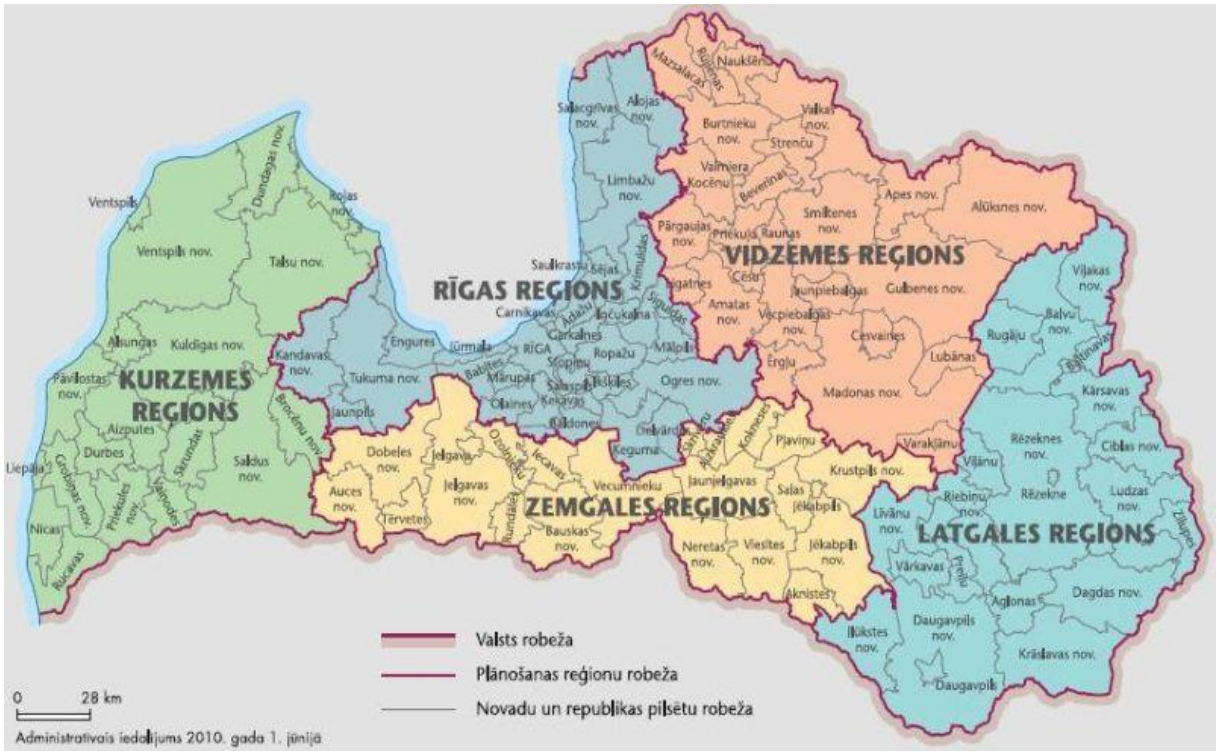


Fig. 1. Five planning regions of Latvia (www.lvportals.lv)

The analysis includes only rural territorial units and their fixed base values. In Latvia rural territorial units by the number of zones distributed by value of zoning are very different.

Generally there are more than one value zone in one rural territorial unit; for example, in Adazi territorial unit (which is equal to Adazi municipality), there are 12 value zones with the base values ranging from 1.71euro/m^2 to 22.77euro/m^2 (Fig 2). However, there are municipality rural territories whose territory is included only in one value zone, for example, Zilupe municipality, which consists of three rural territories, each of them with one value zone and one base value of 0.28 EUR/m^2 (Regulations regarding base ..., 2014).

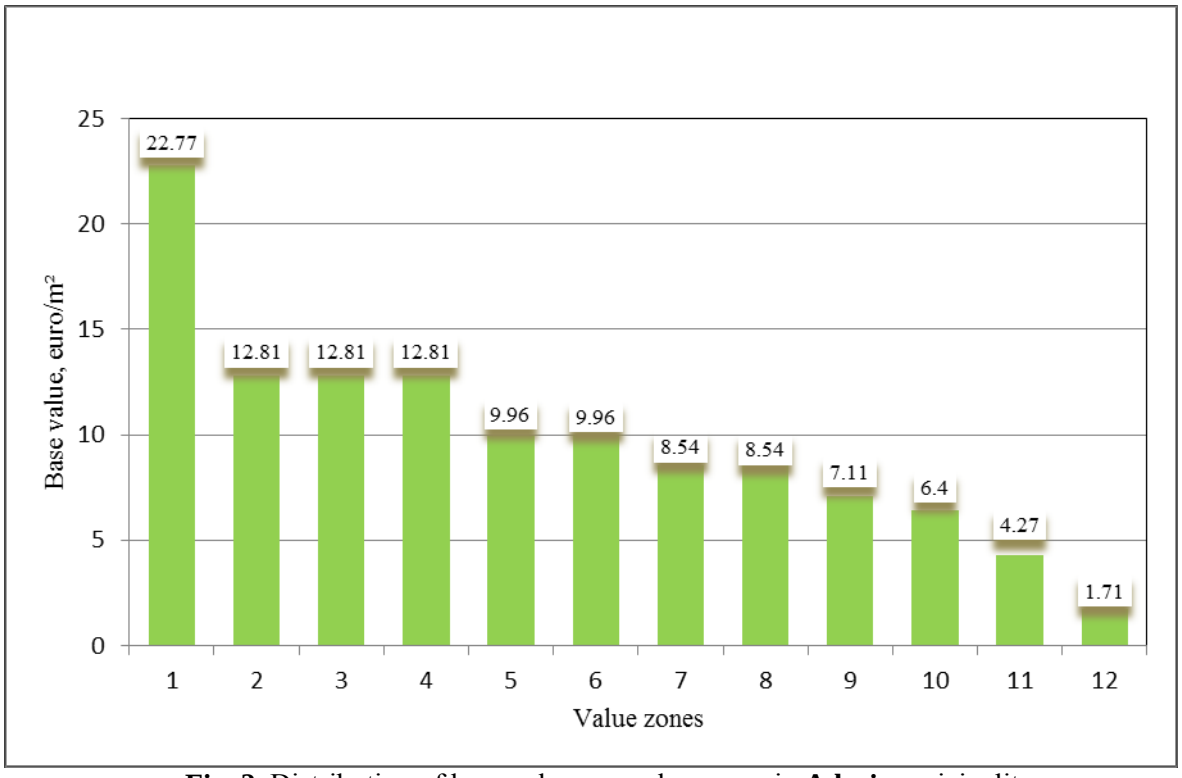


Fig. 2. Distribution of base values on value zones in **Adazi** municipality

The study analyses all Latvian municipalities by its minimum and maximum base values for rural territorial units. For this purpose all Latvian municipality rural territorial units were arranged by they maximum and minimum base value.
In order to collect and analyse data by municipalities and territorial units, Microsoft Excel program was used, as well as mathematical statistical data processing method was applied.

Discussions and results
As of January 1, 2015, 43.6 thousand ha or 0.7% of total land area of Latvia (6448.24 thousand ha) is registered in the Land Register for the purpose to use it for real estate, i.e. individual residential building land (Land Review of Administrative ..., 2015). In 2015, the base values for residential building land in Latvia differ for both territorial units and separate municipalities, divided by municipality territorial units. Therefore, in various municipalities the determined base values of residential building land in rural areas range from 28.46 euro/m^2 to 0.28 euro/m^2 (Regulations regarding base ..., 2014).
For the analysis, at first all Latvian municipalities were grouped based on their territorial units by the **maximum** base values of residential building land, and as a result, five groups were formed within the following base value intervals:

- below 0.50 euro/m^2;
- from 0.51 – 1.0 euro/m^2;
- from 1.1 – 5.0 euro/m^2;
- from 5.1 – 20.0 euro/m^2;
- above the 20.1 euro/m^2.

The results of this grouping showed (Table 1, Fig. 3) that the average maximum base value in Latvia is 3.25 euro/m^2. Out of the total number of municipalities (110), the largest percentage of municipalities have the maximum value in the range of 1.1-5.0 euro/m^2 (43.6%) and are also distributed within the range of 0.51-0.5 euro/m^2 (25.5%). By contrast, the percentage of municipalities with the maximum base value in the range of over 20 euro/m^2 is the lowest (1.8%) (Table 1).

Table 1

Grouping of municipalities based on the interval of maximal base value

Group number	Interval of base value	Number of municipalities	Percentage, %	Average base value, euro/m^2
1	below 0.5 euro/m^2	19	17.3	0.42
2	from 0.51-1.0 euro/m^2	28	25.5	0.73
3	from 1.1-5.0 euro/m^2	48	43.6	2.58
4	from 5.1-20.0 euro/m^2	13	11.8	11.82
5	over 20.0 euro/m^2	2	1.8	25.62
Total		**110**	**100.0**	**3.25**

The highest maximum base values involves territorial units that are located nearby Rīga, the capital of Latvia, such as the Garkalne (28.46 euro/m^2), Ādazi (22.77 euro/m^2), Carnikava (19.92 euro/m^2), Mārupe (7.17 euro/m^2), and Saulkrasti (7.17 euro/m^2) municipalities in the Rīga planning region (Fig. 3).

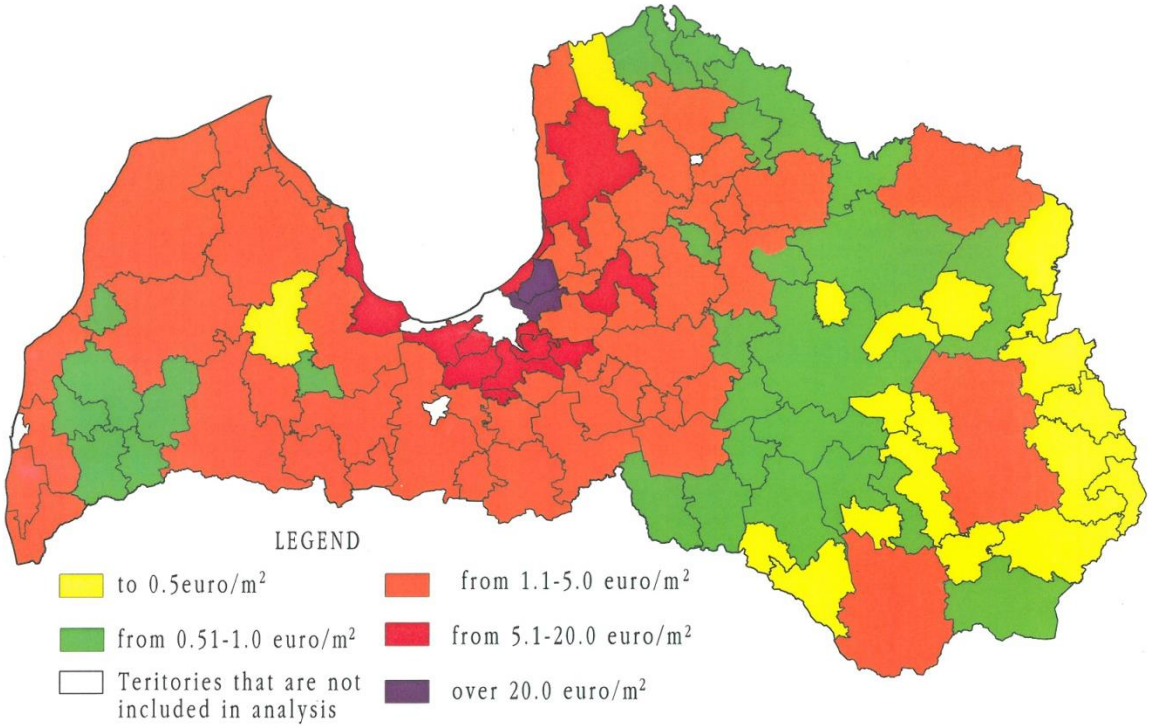


Fig. 3. Distribution of municipalities based on their maximum base values of residential building land, euro/m^2

By contrast, the lowest maximum base values of residential building land involve territorial units in Dagda (0.28 euro/m^2), Zilupe (0.28 euro/m^2), Kārsava (0.43 euro/m^2), and Cibla (0.43 euro/m^2) municipalities, which are located further from the central regions of Latvia, in the east of Latgale.

Minimum base values of residential building land of municipalities and territorial units were also analysed in this study. Minimum base values of individual residential building land are set in the range of 0.28 euro/m^2 to 5.69 euro/m^2. Based on the minimum base values, the municipalities were grouped into four groups within the following intervals of base value:

- to 0.30 euro/m^2;
- from 0.31 – 0.50 euro/m^2;
- from 0.51 – 1.0 euro/m^2;
- above 1.1 euro/m^2.

The average minimum base value of residential building land in Latvia is 0.74 euro/m^2. Most of the municipalities with the lowest minimum base value of residential building land are in the second group, but all four groups have a relatively equal share of the municipalities (Table 2).

Table 2

Grouping of municipalities based on the interval of minimal base value

Group number	Interval of base value	Number of municipalities	Percentage,%	Average base value, euro/m^2
1	below 0.30 euro/m^2	24	21.8	0.28
2	from 0.31-0.50 euro/m^2	38	34.5	0.46
3	from 0.51-1.0 euro/m^2	30	27.3	0.69
4	above 1.0 euro/m^2	18	16.4	2.03
Total		**110**	**100.0**	**0.74**

As shown in Figure 4, the higher minimum base values of residential building land are in the central area of Latvia, in the Rīga region. They are, specifically, Carnikava (5.69 euro/m^2), Garkalne (2.85 euro/m^2), Ķekava (1.99 euro/m^2), and Babīte (1.99 euro/m^2) municipalities, located in the central area around Rīga. Meanwhile, the lowest minimum base values are distributed over the eastern area of

Latvia, for example, the lowest base value of residential building land, 0,28 euro/m^2 are in 24 municipalities, of which 21 are located in the Latgale planning region (Fig. 4).

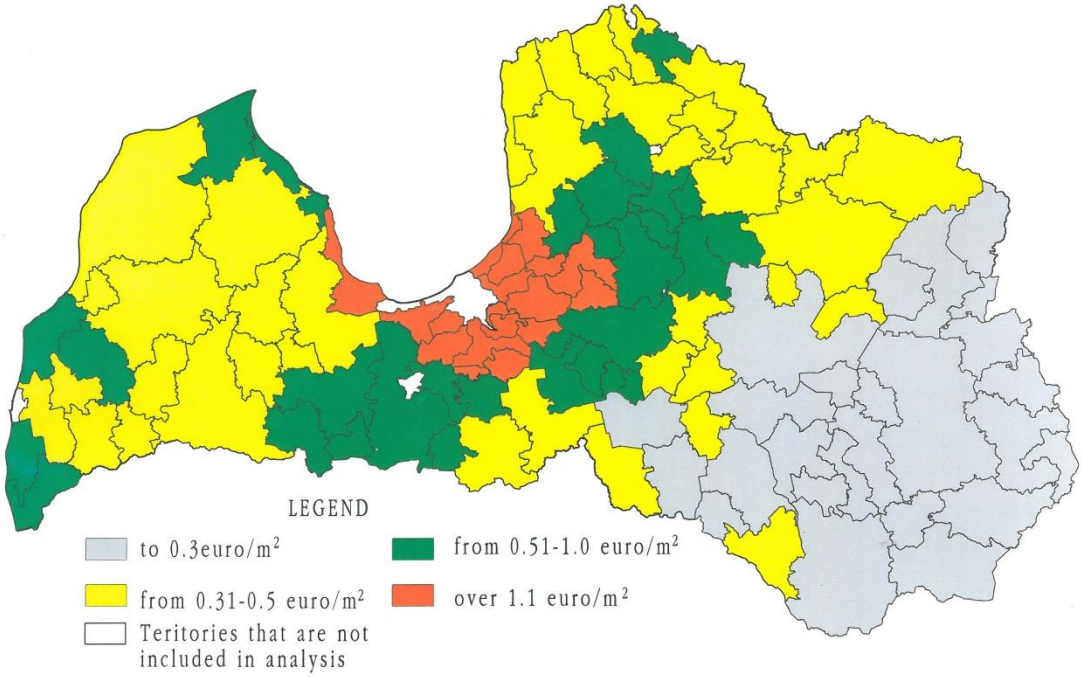


Fig. 4. Grouping of municipalities based on the minimum base value of residential building land

Results of the analysis show that base value grouping of residential building land based on municipalities exhibits a clear polarization. In the municipalities surrounding Riga there are areas with the highest base value of residential building land, but, moving away from Riga to the periphery, the base value decreases rapidly. However, in the central area of Latvia, in which municipalities with the highest base value are located, there are also areas with very different base values. For example, in the Engure municipality there are three territorial units which have different maximum base values that range from 15.65 euro/m^2 in the Lapmežciems territorial unit to 1.99 euro/m^2 in the Smārde territorial unit. Meanwhile, the minimum base value in the aforementioned territorial units have no significant difference (Fig. 5).

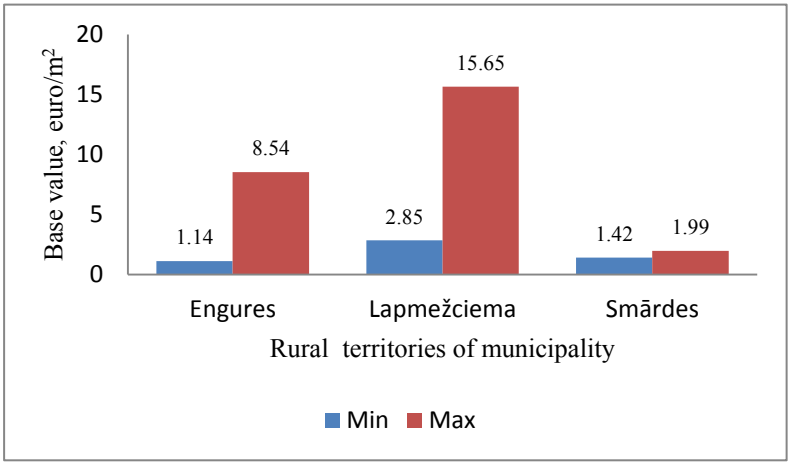


Fig. 5. Base values of the residential building land in the Engure municipality

At the same time, there are municipalities in Latvia whose territorial units has a single base value zone of residential building land and, consequently, a single base value. These are municipalities in the eastern border area, i.e. the Dagda, Zilupe and Kārsava municipalities, where the base value of individual residential building land is only one throughout all territory of municipality. It is also the lowest in Latvia, 0.28 euro/m^2.

When determining **the difference** between the maximum and minimum base value of residential building land in municipalities, it has been discovered that although in municipalities in Latgale the difference between the maximum and the minimum base value is minimal or equal to zero, in municipalities located in the central area of Latvia, where the maximum base value is higher, the difference between the base values is relatively high, for example, in the Garkalne, Ādaži, and Mārupe municipalities they are 25.61 euro/m^2, 21.06 euro/m^2 un 15.79 euro/m^2, respectively (Fig. 6).

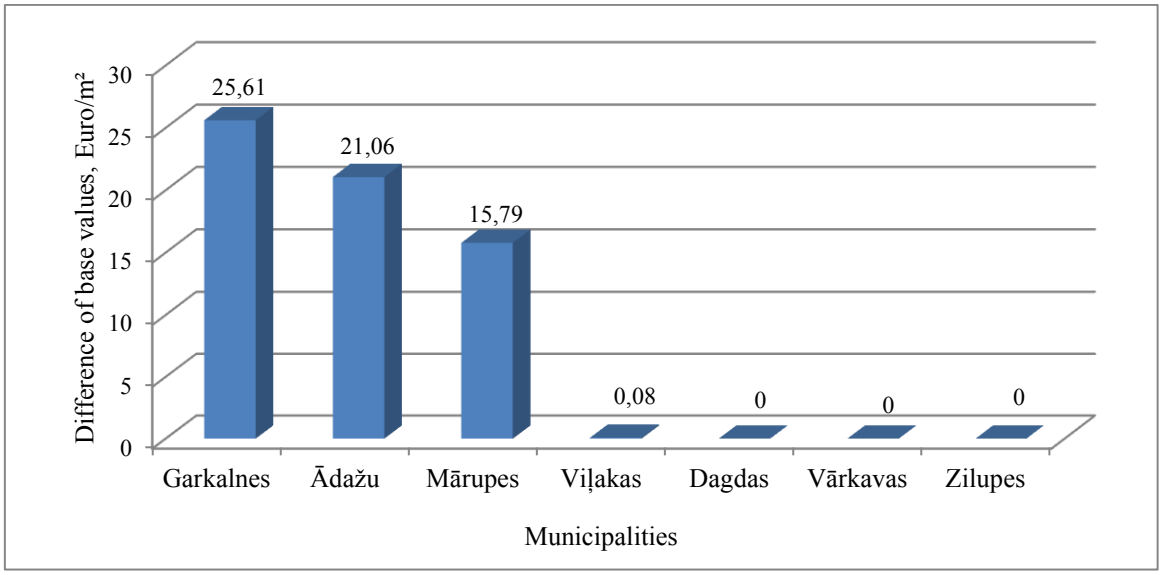


Fig. 6. The difference between the minimum and maximum base values for residential building land

The explanation for this involves various different factors influencing the base values of residential building land. In populated areas located close to Rīga, where new residential house building areas are rapidly developing, the network of streets and the support of engineering communications are developed, which contributes to creating attractive living conditions. Naturally, this increases the market value of the land property and, consequently, the base value as well. At the same time the remaining territory of the municipality, located outside the populated areas demonstrates no factors that could improve the base value, so the base value in these areas is relatively low. It also contributes to the significant difference between the maximum and minimum base value. However, even the lowest minimum base value in areas close to Rīga is ten times higher than the base value in eastern territories of Latvia, even in populated areas (villages, cities), for instance, in the Garkalne municipality the lowest base value is 2.85 euro/m^2, but in the Zilupe municipality it is 0.28 euro/m^2.

Conclusions and proposals

1. The real estate market activity varies in different territories in Latvia, so in order to determine the cadastral value of the land, value zoning has been developed value zoning, involving different base values in different value zones divided based on the purpose of real estate groups, including individual residential building land.
2. Although the average maximum base value of residential building land in Latvia is only a little more than four times higher than the minimum, an obvious polarization in terms of the distribution between the municipalities can be observed. In municipalities surrounding Rīga there are areas with the highest base value of residential building land, but moving away from Rīga to the periphery the base value decreases rapidly.
3. In the central part of Latvia, where the municipalities with the highest base value (Garkalne, Ādaži, Mārupe) are situated, there are several value zones with different base values. Meanwhile, in Latgale there are several municipalities (Zilupe, Vārkava, Dagda), whose territories have a single base value zone.

References

1. Adair A., Downie M., McGreal S., Vos G. (1996). European valuation practice: theory and technique. E&FN Spon, London, 337 pp.
2. Kadastrālās vērtēšanas sistēmas pilnveidošanas un kadastra datu aktualitātes nodrošināšanas koncepcija (Conception of Cadastral Valuation System Improvement and Ensuring of Cadastral Data Topicality) (in Latvian) (http://tap.mk.gov.lv/mk/tap/?pid=40246861).
3. Freibergs I., Žuromskis V. (2013). Nekustamo īpašumu vērtēšanas teorija un prakse. SIA „Eiroeksperts" 347 pp.
4. Latvijas Republikas administratīvo teritoriju un teritoriālo vienību zemes pārskats uz 01.01.2015. (Land Review of Administrative Territories and Rural Territories in Latvian Republic for 01.01.2015), VZD, 2015, 18 lp. (www.vzd.gov.lv./files/zemes_parskats_2014.pdf) (in Latvian)
5. Law on Administrative Territories and Populated Areas: Law of Republic of Latvia (2008). Latvijas Vēstnesis, No.202 (3986), 30th of December 2008.
6. National Real Estate Cadastre Law: Law of Republic of Latvia (2005). *Latvijas Vēstnesis*, No. 205 (3363), 22 th of December.
7. Noteikumi par kadastralo vertibu bazi 2016.gadam (Regulations Regarding Base of Cadastral Value for 2016): Republic of Latvia Cabinet, regulation No.838, adopted 23 December 2014, *Latvijas Vēstnesis,* No. 4 (5322), 8th of Januar 2015 (in Latvian).
8. Regulations Regarding Cadastral Assessment: Republic of Latvia Cabinet of Ministers, regulation No. 305, adopted 18 April 2006, *Latvijas Vēstnesis*, No. 72 (3440), 10th of May 2006, p.3 – 4.

Information about authors

Anda Jankava, Dr.oec., professor, Department of Land Management and Geodesy, of Faculty of Environmental and Civil Engineering Sciences of Latvia University of Agriculture. Address: Akademijas St. 19, Jelgava, Latvia, LV-3001, phone: +37163026152, e-mail: anda.jankava@llu.lv. Fields of interest: land reform, land consolidation, size of land property, land use planning.

Aina Palabinska, Mg.oec., lecturer, Department of Land Management and Geodesy, of Faculty of Environmental and Civil Engineering Sciences of Latvia University of Agriculture. Address: Akademijas St. 19, Jelgava, Latvia, LV-3001, phone: +37163026152, e-mail: aina.palabinska@llu.lv. Fields of interest: cadastral assessment of real property, territorial planning.

Dace Didrihsone, Mg. sc.ing., lecturer, Department of Land Management and Geodesy, of Faculty of Environmental and Civil Engineering Sciences of Latvia University of Agriculture. Address: Akademijas St. 19, Jelgava, Latvia, LV-3001, phone: +37163026152, e-mail: dace.didrihsone@llu.lv. Fields of interest: geodesy, land surveying, territorial planning.

THE ASSESSMENT OF LITHUANIAN RURAL RESIDENTIAL AREA STRUCTURE

Daiva Juknelienė, Vilma Sinkevičiūtė, Virginija Atkocevičienė
Aleksandras Stulginskis University

Abstract
The contemporary rural residential area system formed under specific circumstances characteristic to a particular region and under historic, economic, politic and social details of residential area development. This article studies the influence of natural factors to the formation of rural residential area system, discusses the problem of residential area vanishing and the factors that influence the development of current residential areas. The main factor that influences the changes of the Lithuanian rural residential area structure that started in the 20th century and is still ongoing, is the political changes in the country, however, economic and social aspects also played a minor role in it. The oldest forms of Lithuanian residential areas are as follows: 1) scattered settlements near mounds, 2) stack settlements, 3) a specific part of grunges. The development of settlements was greatly influenced by the Volok Reform. The old stack settlements and separate granges should have been vanished and relocated to linear settlements that were nearer to the manor. Throughout time it did not meet the advanced farming requirements. The solution was to divide it into granges. During the interwar period the aim of the land reform, which was implemented in Lithuania, was to establish better conditions for the building of grunges in private land holdings. After the restoration of independence, the organisation and size of the land holdings formed in land management projects was not related to the establishment of farms and their internal structure as well as the residential place of the owner. Thus taking into consideration the land regulation relationships peculiar to each period and the performed analysis of rural residential area structure development some tendencies of changes are presented.
Key words: settlement, grunge, land reform, residential area development.

Introduction

During the last decade the processes of globalisation and integration became increasingly active, and although they bring nations and their cultures more close, they also result in gradual disappearance of national identity. This process encompasses various fields, however, its biggest influence is on the condition of country's towns, cities and villages and their demography, urban development, landscape, which gradually lose their visual aesthetic identity, originality. Thus the problem of saving and cherishing the features of country's landscape, the nature of residential area spatial structure as well as natural environment during the process of globalisation is very relevant.

When analysing the changes in rural residential area development, E. Kriaučiūnas (2012) claims that they are haphazard, while the state and municipal institutions have only minor influence on demographic, social and economic processes that occur in the residential areas. Evidentially there exists a lack of not only financial resources, but also a single, common state outlook towards the future of the rural residential areas. L. Dringelis (2013) points out that the changing demographic situation, which is related to the economic state of Lithuania, is an important factor that determines the urban changes, i.e. the decrease and vanishing of towns, cities and villages. It is a vicious circle formed by the correlation of the abovementioned factors: economics, demographics and urban development. Taking into consideration the results of the statistical analysis of the Population and Housing Census of 2001 and 2011 performed by Statistics Lithuania, L. Dringelis (2013) determined that within the period of 2001-2011 the number of residents dropped by 440.37 thousand or 12.64%. During this period the number of cities (from 106 to 103) has dropped accordingly, whereas the number of villages (from 19 842 to 19 004) and khutors (from 1735 to 1687) has dropped significantly. Furthermore, 18% of villages and 52% of khutors that are included in the current data of villages and khutors have no residents and are on the verge of vanishing. There is no doubt that the abovementioned demographic and urban development changes influence the singularity and identity of Lithuanian towns, cities and villages' landscape spatial structure. Such singularity, as an important part of the national cultural heritage, can be saved only by finding a complex solution for economic, juridical, natural and cultural issues.

General Territorial Plan of the Republic of Lithuania (Lietuvos...., 2002) indicates that during the development of relations between urban and rural territories, one must re-create the rural residential area systems in new social and economic conditions. The important step that can be taken is the development of municipality centres, i.e. small towns and cities as an agriculture production and village resident service, partially the city resident recreation centres. The authors that have researched

these issues offer to carry out better integration of cities and regions, create conditions for sustainable network of small and medium size cities by avoiding "urban sprawl" and depopulation of rural residential areas (Čereškevičius, 2012).
The forms and types of residential areas are determined by historic and socio-economic conditions of the land. Throughout history, the development of production relations influenced the change in population system in rural areas. The important role in the rural development was played by the changes in land ownership and land management.
The development of Lithuanian rural residential areas has been researched by various authors. Each one of them provide their own conclusions, assessments, opinions, offers and critical remarks about specific phenomenon as well as interpret and explain various facts in their own way (Rupas, Vaitiekūnas, 1971; Butkevičius, 1971,1980; Milius, 1999; Bučas, 1988, 2001; Aleknavičius, Miknius, 2001; Aleknavičius, Survila, Tarvydienė, 2004 et al.).
The analysis of rural residential areas is relevant due to the following aspects:
1. Administrative-political. Lithuanians have long been living in villages. Currently, the village is one of the types of residential areas. The Law on the Territorial Administrative Units of the Republic of Lithuania and their Boundaries (Lietuvos..., 1994) sets out that rural residential areas include towns, villages and khutors. Thus the notion of village is practical rather than theoretical. The solving of various issues related to residents and residential areas is possible only after having thoroughly analysed the structure and the development of residential areas.
2. Economic. Currently, attempts have been made to assess the present development trend of rural residential areas by evaluating the destruction of granges and the establishment of residential areas in its former place. Did the granges really cause inconveniences in terms of production, social and political-educational work?
3. Ecological. When forming the theory and practice of residential area, the focal points were the political and economic factors. The natural factors were not properly evaluated or they were regarded in a primitive or formal way. Our residential areas were formed without having a solid geo-ecological background.
4. Cultural-historical. Former settlements as well as other residential areas are the historical heritage of our land's development. Taking case of this heritage is the matter of our inner culture. The biggest problem is the vanishing of settlements and the preservation of the names of former settlements.
The *aim* of this article is to analyse the peculiarities of the development of Lithuanian rural residential area structure that are influenced by political, economic changes and natural conditions.
To reach the abovementioned aim the following *objectives* have been set out:
- to analyse the peculiarities of the development of Lithuanian rural residential area structure in ethnographically different Lithuanian regions with different natural conditions;
- to determine the land regulation relationships peculiar to each period and after carrying out the analysis of the development of rural residential area structure to present the tendencies and reasons of changes.

Methodology of research and materials
The abovementioned aim is reached by applying statistical data and cartographic material, scholarly literature analysis, legal document analysis and synthesis, comparative analysis and descriptive methods of research. At the beginning of the 20th century, 5 regions of administrative territories were chosen for the analysis of the structure of residential areas. These are the following: Alytus, Utena, Pasvalys, Varena, Silute (part of the region) since the territories of these regions differ in natural conditions (feature different types of landscape) and historically determined ethnographic peculiarities. Therefore, the settlements in the regions were classified into groups according to the number of yards. Granges (forest guard sectors included) as well as manors and folwarks were distinguished as different structural groups of residential areas. The main material used for the research is received from Public Institution National Land Fund: Topographic maps M1:100000 of the end of 19th century. The obtained data was systematised and summarised.

Results and discussion
The Lithuanian rural residential areas have gone a long and complicated road of development, whose analysis helps us to better understand their current network, structure, architecture, etc. The historic characteristics of settlement development are necessary not only to acquire the knowledge of one's past. Without it, the prognosis of settlements future, the manor and trends of its development cannot

be made.
The 20th century was exceptionally known for a myriad of socio-economic reforms. Each reform influenced the face of the settlement differently and formed the unique rural residential area system. Throughout history, two main types of villages existed in Lithuania, i.e. stack and linear settlements. After the Volok Reform in the middle of the 16th century, linear settlements set in Lithuania. A part of settlements that did not change their form or changed it only slightly survived until the 20th century. With the increase of families and splitting of farms among family members the settlements became denser. During the implementation of various reforms the majority of settlements suffered a loss of population, thus scarce linear settlements were created.
The origin of another form of Lithuanian peasant rural areas, i.e. granges, was very diverse; some of the granges survived from the oldest times, others were created during the period of Volok Reform or were established during different periods which began in the 19th century and ended in 1939. After the collapse of collectivisation after the Restoration of Independence of the Republic of Lithuania in 1990, granges gradually start to be established.
A. Basalykas (1977) points out that at the end of the 19th century various parts of Lithuania featured a highly different rural residential areas. Grunges prevailed in Western Samogitia, however some plot settlements, large scarce linear settlements, manors and folwarks were also present. After the Land Commasation, linear grange settlements were formed in the south of Uznemune. Middle length linear settlements, manors and folwarks still dominated in Middle Lowland. Shorter linear settlements were characteristic of hilly moraine highlands and stack settlements dominated in sandy plains of South-Eastern Lithuania.
As it was mentioned before, at the beginning of the 20th century 5 regions of administrative districts were chosen for an in-depth analysis of the structure of residential areas. These are the following: Alytus, Utena, Pasvalys, Varena and Silute (a part of the region). Having analysed the collected data it is obvious that in some districts the natural conditions, i.e. hilly landscape, impeded the formation of large settlements. For instance, settlements of 10 farms comprised 46% of residential areas in Utena district and only 27% in Alytus district. However, in Pasvalys district, whose natural conditions are closer to Alytus, the number of such settlements reached 39%. It may be supposed that the reasons can be found not only in natural but also in economic, ethnographic and political conditions. The same tendencies can be observed in the territory of the same district when comparing the cadastral areas as separate territorial units (comparing the cadastral areas that belong to different types of landscapes) (Table 1).

Table 1

The structure of Lithuanian rural residential areas at the end of the 19th century – at the beginning of the 20th century

District and the classification of settlements according to the number of yards	Area of the territory ha	Total of residential areas	Settlements (number/%)			Granges, forest guard sectors (number/ %)	Manors, folwarks (number / %)
			total	of which			
				linear settlements	granges		
1	2	3	4	5	6	7	8
Western part of Alytus district (Uznemune)							
Santaika cadastral area	2643	24	16/67	-	16/100	6/25	2/8
up to 10 yards			4/25				
from 11 to 25 yards			6/37				
from 26 to 50 yards			3/19				
more than 50 yards			3/19				
Parecenai cadastral area	3103	29	16/55	-	16/100	10/35	3/10
up to 10 yards			8/50				
from 11 to 25 yards			2/12				
from 26 to 50 yards			3/19				
more than 50 yards			3/19				
Kavalciukai cadastral area	2265	15	10/69	-	10/100	2/14	3/20
up to 10 yards			1/10				
from 11 to 25 yards			4/40				

1	2	3	4	5	6	7	8
from 26 to 50 yards			4/40				
more than 50 yards			1/10				
Eastern part of Alytus							
Punia cadastral area	4394	14	8/57	8/100	-	4/28	2/15
up to 10 yards			3/37				
from 11 to 25 yards			1/15				
from 26 to 50 yards			5/37				
more than 50 yards			-				
Gervenai cadastral area	4993	29	18/55	18/100	-	7/28	4/17
up to 10 yards			5/27				
from 11 to 25 yards			8/46				
from 26 to 50 yards			5/27				
more than 50 yards			-				
Pivasiunai cadastral area	3053	12	8/67	8/100	-	3/25	1/8
up to 10 yards			1/12,5				
from 11 to 25 yards			2/25				
from 26 to 50 yards			4/50				
more than 50 yards			1/12,5				
Utena district							
Klykiai and Juknenai	6212	25	18/72	18/100	-	5/20	2/8
up to 10 yards			5/27				
from 11 to 25 yards			10/55				
from 26 to 50 yards			2/12				
more than 50 yards			1/6				
Leliunai cadastral area	5176	38	19/49	19/100	-	13/35	5/14
up to 10 yards			15/75				
from 11 to 25 yards			5/15				
from 28 to 50 yards			-				
more than 50 yards			-				
Viluciai and Kaimynai cadastral areas	5397	26	18/69	18/100	-	5/19	3/12
up to 10 yards			8/43				
from 11 to 25 yards			9/49				
from 26 to 50 yards			l/8				
more than 50 yards			-				-
Pasvalys district							
Kiemenai I, Kiemenai II and Namisiai cadastral areas	8233	26	12/46	12/100	-	4/5	10/19
up to 10 yards			4/53				
from 11 to 25 yards			3/25				
from 26 to 50 yards			3/25				
more than 50 yards			2/17				
Mikoliskis and Pusalotas cadastral areas	14187	21	17/81	17/100	-	2/9,5	2/9,5
up to 10 yards			5/39				
from 11 to 25 yards			10/59				
from 26 to 50 yards			2/2				
more than 50 yards			-				
Varena district							
Vilkiautinis cadastral area	3850	14	10/72	9/89	1/11	2/14	2/14
up to 10 yards			2/20				
from 11 to 25 yards			4/40				
from 26 to 50 yards			3/30				
more than 50 yards			1/10				
Zilinai cadastral area	6490	17	14/82	14/100	-	3/18	-
up to 10 yards			9/65				
from 11 to 25 yards			3/21				
from 26 to 50 yards			2/14				
more than 50 yards			-				
Silute district							
Bikavenai, Kivyliai, Vainutas cadastral area	14771	15	12/80	3/25	9/75	1/7	2/13

1	2	3	4	5	6	7	8
from 26 to 50 yards			3/25				
more than 50 yards			2/16,5				
Sveksna cadastral area	10617	14	12/85	-	12/100	-	2/15
up to 10 yards			8/66				
from 11 to 25 yards			3/25				
from 26 to 50 yards			-				
more than 50 yards			1/8				

Note: The percentage of the number of settlements provided in the classification of settlements by yards is calculated from the number of settlements in the investigated territory, while other percentage data is calculated from the total number of residential areas in the territory.

Average distance among the linear settlements was calculated from the existing data by using the formula of professor A. Seselgis:

$A = Q/k,$

A – the distance among linear settlements in meters; Q – area of the territory in m²; k – number of settlements in the territory.

The obtained results do not comply with the data of the authors that investigated linear settlements of that period. A. Basalykas (1977) claims that the linear settlements that were established after the Volok Reform were within 3-4 km of distance from one another. Manors and folwarks were among them. Plot settlements established in clay plains were longer and straighter, while the ones that were located in hilly moraine landscape were shorter, not so correct in form and more dense Sandy plains were characterised by the establishment of smallest plot settlements or the remaining of archaic stack settlements. The data obtained during the research, i.e. the distances among settlements, is presented in Table 2. Once again it clearly indicates the dependence on the landscape conditions. In Utena and Alytus districts, where the relief is more distinct and its forms are more diverse, the distance between settlements is less than 2 kilometres, while in Silute and Pasvalys districts, whose relief does not feature a variety of forms, the distance among settlements is 2.5 - 3.5 kilometers.

Table 2

Distance among linear settlements in Lithuania in the end of the 19th c. – beginning of the 20th c.

Territory	Area of the territory ha	Number of villages	Distance between villages m
Alytus district			
Gervenai cadastral area	4933	18	1655
Pivasiunai cadastial area	3053	8	1953
Punia cadastral area	4394	8	2344
Average			**1908**
Utena district			
Viluciai and Kaimynai cadastral areas	5397	18	1732
Klykiai and Juknenai cadastral areas	6212	18	1858
Leliunai cadastral area	5176	19	1650
Average			**1746**
Silute district			
Bikavenai, Kivyliai, Vainutas cadastral areas	14771	12	3508
Sveksna cadastral area	10617	12	2974
Average			**3252**
Pasvalys district			
Kiemenai I, Kiemenai II and Namisiai cadastral areas	8233	12	2619
Mikoliskis and Pusalotas cadastral areas	14187	17	2888
Average			**2780**
Varena district			
Vilkiautinis cadastral area	3850	10	1962
Zilinai cadastral area	6490	14	2153
Average			**2075**

Further settlement reorganisation at the beginning of the 20th century was influenced by Stolypin agrarian reform which left the main question of providing land holdings to peasants still unanswered. The division into granges become more active in 1922 due to the interwar Lithuanian land reform. Grange is an element of settlement system and building structure which existed during all the land reforms. Dissolution of settlements and the founding of granges have reached the peak in 1930, when from 360 to 570 settlements were being dissoluted each year. The biggest share of granges was established in 1930-1939. The annual average number of new granges increased by more than 11 thousand. After 1930 the dissolution of settlements was encouraged the fact that more surveyors have been trained and the parcellation of manors has already ended. The number of dissoluted settlements and established settlements starts to drop in 1934-1935. It is influenced by world financial crisis, the ongoing dissolution of small settlements as well as the disappointment that was felt by the owners of small land holdings because of land reform, since at that time a lot of new dissoluted settlers have lost their land i.e. until 1938 the land was sold by 22% of new settlers. Furthermore, the average grange land plot had dropped increasingly. Since 1932 one grange occupied less than 10 ha of land. The Public institution National Land Fund estimated the size of granges in Moletai, Pasvalys, Silute regions. The estimated size of granges varies greatly: In Pasvalys region - 16.0 ha, Silutes region - 25.0 ha, Moletai region - only 6.00 ha. According to I. Butkevičius (1971), the size of a grange is determined by the natural and ethnographic conditions of the land.

The majority of settlements were dissoluted in districts that are located in fertile areas, especially in the fertile Middle Lithuania Plain. While the sandy Aukstaitija and Dzukija regions feature a significantly lower percentage of settlement dissolution to granges.

The settlement dissolution to granges was to be finished in the period of 19-20 yeards, however at the end of 1939, 2811 settlements were still not dissoluted (Šešelgis, 1996). 1919 - 1939 marked the establishment of 159118 granges (Grabauskas, 1983). If taking into account the already existing granges, at the end of 1939 there were 229000 granges in Lithuania. Taking into consideration the fact that the remaining non-dissoluted settlements are relatively small it can be stated that at the eve of Soviet occupation the settlement dissolution to granges in Lithuania was finished.

Construction of new type of kolkhoz and sovkhoz settlements began during the Soviet period. The rural settlements and their growth were formed during the reorganisation of the network of historical settlements and building of objects for production and recreational purposes. The main trend of reorganisation is the increasing of the size and reducing the number of settlements. During the Soviet period, 124049 granges in total were destructed in Lithuania. In 1988, there were only 118000 granges left in Lithuania (Aleknavičius, 1996). In the beginning of collectivisation, kolkchozes were created as villages. Villages used to be visible units, they used to have significance because they were separate administrative units. Later on, in increasing of the size of kolkchozes, the boundaries of villages were no longer taken into account. Village lands were shared between separate users, i.e. kolkchozes, sovkhoz settlements, and forestry. There were 92 villages shared between separate users in Silute district, 107 in Plunge district, 40 in Pasvalys district, and 56 in Moletai district. Works of reclamation were also projected and carried out as separate objects. The arrangement of objects as a territorial unit was caused by farms, rather than villages. Former boundaries of villages no longer have a function in landscape, they have actually vanished, i.e. a village is not an administrative territorial unit. Agricultural holdings were the main territorial structures which carried out economic and social activities in a village. In some places, it is possible to trace back the boundaries of such villages according to natural components of landscape: forests, rivers, and in some other places according to roads. The boundaries of villages that we can now see in certain maps are conditional. Actually, the boundaries of former villages have already vanished. So, there is no more life in a village as a unit. The concept of "village" is gradually losing its former meaning. The most important outcomes of the aforementioned prerequisites, i.e. collectivisation, reclamation, formation of a new network of rural residential areas are as follows: vanishing of the most important rural elements - granges and formation of a network of rural residential areas. Vanishing of granges was the reason why the residential areas themselves began to vanish. The statistical and cartographic correction of residential areas (withdrawal, combination) was laid down by the documents of the current Executive. The first documents regarding the withdrawal of residential area and accounting data appeared in 1961, there were 16 of them in total (starting from 1961 up until 1988). The first documents regarding the combination of residential areas appeared a bit later, in 1968. There were 18 of them up until 1988 (inclusive). During this period, 3428 rural residential areas vanished in Lithuania. The vanished rural residential areas of the studied territories are presented in Table 3.

Table 3

Vanished rural residential areas

The name of the district	Residential areas which vanished due to withdrawal		Residential areas which vanished due to combination		Total of vanished residential areas
	villages	granges	villages	granges	
Alytus	14	10	18	20	62
Pasvalys	45	29	-	-	74
Šilutė	20	2	17	-	39
Utena	17	38	4	3	62
Varėna	1	2	4	-	7
Total:	97	81	43	23	**244**

As the old system of rural residential areas (granges) was vanishing, a new population system in rural areas was developing, the basis of which was residential areas. Cities and roads have a significant importance on the growth of residential areas and their territorial distribution. Around 40 % of all rural residential areas are near main roads. As the distance to main roads becomes greater, the number of residential areas diminishes. Villages, even big ones, that are further from cities, are losing their residents; small villages have a tendency to vanish completely. According to P. Aleknavičius (2007), without residents, the land lies fallow and gradually becomes unsuitable to use without additional land reclamation tools. Further diminution of rural areas residents might result in abandonment or extensive use of fertile areas of land and in vanishing of villages. However, changes in rural areas resident number are also associated with the intensity of cultivation of land. In territories with potentially the most fertile soil, the productivity score of utilised agricultural area is higher; there is the most cultivated land due to land reclamation; the income is higher.

According to the data of the General Territorial Plan of the Republic of Lithuania (Lietuvos..., 2002), the density of the network or residential areas shifts from east to west, the network of residential areas significantly grows rare in the west. The most dense network of residential areas is in Moletai district: 67.5 residential areas per 100 km^2; the most rare is in Mazeikiai district: 16 residential areas per 100 km^2.

In 1989-2004, 112 laws and other legislations entered into force regarding the matters of development of agriculture and rural areas. In 2004, Lithuania became a member of the European Union. In recent years, four major specialised functional zones have been formed in the agricultural landscape of Lithuania: residential, industrial, recreational, and the reservation zone. Residential zone is composed of settlements and granges. Industrial zone is composed of two parts: industrial centres and industrial land (water, forests, and agricultural land). In agricultural territories designed for intensive production, it is necessary to create various recreational zones. The aim of reservation zone is the protection of natural resources and cultural heritage.

The traditions of agricultural landscape management must be also preserved during present land reform, therefore the principle of historical continuity should be applied here. The environment must be managed by taking over ethnographic elements and structures of heritage. When managing the territory of geosystems, the principle of geo-ecological balance must be preserved. When adapting to natural landscape, areas of land, means of optimisation of areas of land, buildings construction features, roads, etc. are evaluated. In this way, harmonious cultural landscape is formed in a complex manner. This adaptation is called the principle of natural adaptation. New buildings must not be contrary to the requirements of aesthetics, ecology, economics, and nature protection. Plantations must be formed as a unified system which diversifies the landscape. Linear plantations, which take up a small area, are planned for fertile plains. Grove plantations are planned for hilly areas of small relief, unsuitable for agriculture.

One of the measures of the State to regulate the development of rural residential areas is the decisions and the organisation of their implementation of general territorial plans of municipalities. These planning documents provide the perspectives of the development of chosen centres of social service of residents, including the development of infrastructure and the measures corresponding to the needs of residents and business. Recently, the projects of rural land management are becoming more and more popular, which should be related to possibly the most detailed administration of operators of the funds allocated to agriculture and rural areas development. The programme documents of the Lithuanian Rural Development Programme for 2014-2020 (Kaimo..., 2014) provide that one of the main

objectives of the EU Rural development support is to increase the competitiveness of all kinds of agricultural activity and the viability of farms; to promote social inclusion, poverty reduction and economic development in rural areas.

Conclusions

1. The research of settlements has shown that a certain regularity became apparent. It shows that each socio-economic formation determining different land management had a substantial impact on the changes of forms of settlements. Therefore, throughout history, mostly a single defined form of rural settlements has been prevailing in each socio-economic formation.
2. The biggest changes in residential areas in Lithuania occurred in the 20th century. They were determined by economic reforms: Stolypin agrarian reform in 1906, the interwar Lithuanian land reform in 1922, Soviet land reform, the land reform that has begun after the Restoration of Independence and still continues today. There were no so many reforms in the past. The natural factors should also be mentioned (relief, soil, hydrography), which had relevant effect on the size, shape, etc. of residential areas in different regions. Throughout history, the structure of residential areas, even the concept and the functions of village changed. It is clearly observable in reorganisations during the Soviet period. Previously, for many ages, the concept of "village" was inseparable from the concept of "territory, land". When soviet agriculture holdings were created, the village, as an autonomous unit, lost its significance. The most important components of a village, i.e. granges, began to vanish, and consequently even the villages themselves had vanished. This being a very important cultural heritage part of a nation can only be preserved by addressing economic, legal and demographic issues in a complex manner.
3. Recurrence can be observed in the development of Lithuanian rural residential area. Socialist agriculture reorganization in territorial aspect of the structure of settlements: recurrence of Volok reform in other economic, social and political conditions; and the present Land reform are in a sense "a step back" to Lithuania of interwar period.
4. When preparing general plans, the planning of rural residential areas should be addressed in a complex manner, together with the issues of agricultural territories management, addressed in projects of rural land management, and adjusted with the rural development programme implementation measures which could be implemented in certain municipalities and by preserving our culture-historical heritage.

References

1. Aleknavičius, P. (2007) Kaimiškųjų teritorijų žemės naudojimo problemos, Žemės ūkio mokslai 14(1): 82–90 p.
2. Aleknavičius, P. (1996) Lietuvos žemės santykių ir žemėtvarkos istorijos apžvalga //Žemės tvarkymo darbai Lietuvoje nuo seniausių laikų iki 1990 metų. – Lietuvos žemėtvarkos ir hidrotechnikos inžinierių sąjunga, Kaunas
3. Aleknavičius, P. (2001) Žemės reformos žemėtvarkos parengiamieji darbai. Pirmasis Žemės Reformos dešimtmetis. Vilnius.
4. Aleknavičius, P., Survila, R., Tarvydienė, E. (2004) Žemės tvarkymo raida iki 1918 m. Žemėtvarka Lietuvoje. – Valstybės įmonė Valstybinis žemėtvarkos institutas, Vilnius.
5. Aleknavičius, P., Miknius, A. (2001) Žemėtvarka: praeitis, dabartis, perspektyvos. Pirmasis Žemės Reformos dešimtmetis. – Vilnius.
6. Basalykas, A. (1977) Lietuvos TSR kraštovaizdis. – Vilnius.
7. Bučas, J. (1988) Lietuvos kaimo kraštovaizdžio raida ir istorinės vertybės. – Vilnius.
8. Bučas, J. (2001) Kraštotvarkos pagrindai. – Technologija, Kaunas,.
9. Burinskienė, M.; Lazauskaitė, D. (2010) Mažų miestelių, bažnytkaimių, kaimo gyvenviečių perspektyvos, iš IV Lietuvos urbanistinis forumas. Urbanistinė drieka: miesto ir kaimo sandūra, 34–39 p.
10. Butkevičius, I. (1971) Valstiečių gyvenvietės ir sodybos. – Vilnius.
11. Butkevičius, I. (1980) Lietuvos socialistinio kaimo gyvenviečių formavimasis. – Vilnius.
12. Čereškevičius, S. (2012) Besitraukiančių miestų fenomenas: erdvinės struktūros pokyčiai, revitalizacijos principai ir vystymo galimybės, iš VI Lietuvos urbanistinis forumas. Šiuolaikiški miestai ir miesteliai: situacija, vystymosi tendencijos, vizija, 24–32 p.
13. Dringelis, L. (2013) Lietuvos miestai, miesteliai ir kaimai: jų urbanistinių ir demografinių pokyčių įtaka šalies kraštovaizdžio erdvinės struktūros savitumui, Journal of Architecture and Urbanism 37(4): 310–323 p.
14. Grabauskas, B. (1983) Lietuvos TSR žemės ūkio socialinė raida. – Vilnius.
15. Kriaučiūnas, E. (2013). Lietuvos kaimo gyvenviečių tinklo kaitos ypatumai 1989–2011 metais, Kaimo raidos kryptys žinių visuomenėje 1(5): 53–60.
16. Lietuvos Kaimo plėtros 2014–2020 metų programa [interactive], Internet access:

https://www.nma.lt/index.php/parama/lietuvos-kaimo-pletros-20142020-m-programa/apie-programa/4911
17. Lietuvos Respublikos bendrais planas [interactive], Internet access: http://www.am.lt/LSP/files/Aplinkapilnas.pdf
18. Lietuvos Respublikos teritorijos administracinių vienetų ir jų ribų įstatymas (1994 07-19 Nr. I-558). Valstybės žinios, 1994, Nr. 60-1183, 2003, Nr. 115-5194.
19. Rupas, V., Vaitiekūnas, S. (1971) Lietuvos kaimo gyventojai ir gyvenvietės. – Vilnius.
20. Šešelgis, K. (1996) Lietuvos urbanistikos istorijos bruožai. – Vilnius.
21. Šešelgis, K. (1971) Rajoninio planavimo ir urbanistikos pagrindai. – Vilnius.

Information about authors

Daiva Juknelienė. Lecturer, Institute of Land Use Planning and Geomatics, Faculty of Water and Land Management, Aleksandras Stulginskis University. Address: Universiteto 10, LT-53361, Akademija, Kaunas r., Lithuania, Tel. + 370 37 752372 . e-mail: daiva.jukneliene@asu.lt. Fields of interest: land law, rural development, land-use management.
Vilma Sinkevičiūtė Lecturer, Institute of Land Use Planning and Geomatics, Faculty of Water and Land Management, Aleksandras Stulginskis University. Address: Universiteto 10, LT-53361, Akademija, Kaunas r., Lithuania, Tel. + 370 37 752372. e-mail: vilma.salkauskiene@asu.lt Fields of interest: geodesy, spatial planning.
Virginija Atkocevičienė. Lecturer, Institute of Land Use Planning and Geomatics, Faculty of Water and Land Management, Aleksandras Stulginskis University. Address: Universiteto 10, LT-53361, Akademija, Kaunas r., Lithuania, Tel. + 370 37 752372 . e-mail: virginija.atkoceviciene@gmail.com Fields of interest: land cadastre, rural development, land-use management.

THE REQUIREMENTS TO CREATE A GEODETIC INSTRUMENT CALIBRATION POLYGON

Irēna Kukule, Armands Celms, Vivita Baumane
Latvia University of Agriculture

Abstract
In this paper, the environmental, climatic and geological obstacles preventing the development of the most suitable geodetic instrument calibration polygon in Latvia are shortly described. Having assessed the information from previous researches in the relevant fields of science, Engure municipality was selected as the target place for the establishment of the calibration polygon. In order to confirm the suitability of territory during the cameral work, the most suitable 17 land plots were selected and later surveyed on field works. The results of the survey showed that only 8 of selected land plots were suitable or partially suitable for creating a calibration polygon, but only one of the selected land plots met all the requirements completely.
Key words: geodetic instrument calibration polygon, geodetic instrument

Introduction

With the current rapid development of science and technologies, the number of geodetic instrument and instrument application users increases every day. Nowadays these actions manifest themselves not only as the usage of instruments in surveying or other geodesy works, or as scientific development, where they are usually employed by well-qualified specialists of an area, but also as tools to make multiple daily tasks easier, where they are used by lay people and other unqualified users. Considering the varied usage of instruments there are situations when a necessity to check and control some quality indicators of instruments arises among unqualified users. The biggest issue concerning these situations in Latvia is related to the fact that there are only a few calibration laboratories that possess the necessary equipment, but they are restricted for the majority of people, especially for those without any qualification in the field of geodesy or similar fields. These reasons propose a necessity of a place to control quality indicators of instruments that would be available for everyone.

The need to control the quality indicators of instruments is manifesting itself with the fact that after using a geodetic instrument on regular basis, it starts to depreciate and loses the initial quality of some indicators and then needs to be checked and restored. In order to avoid the frequent process of restoring the initial quality of the instrument, calibration needs to be performed. Legislation (About the Conformity Assessment, 1996; About the Measurment Unity, 1997) defines calibration as an operation, involving a process with certain obstacles present, during which a connection between a measurement instrument or a size of values indicated in the measuring system and an adequate benchmark are recognised. So the necessity to develop a calibration polygon open for everyone along with better availability to modern geodetic instruments has only become more significant.

The increasing necessity has stimulated the idea to develop a project of an open field geodetic instrument calibration polygon, but in order to start the development it is necessary to explore all potential territories considered suitable for the polygon. The main aim of the research is *to define the most suitable territories for the establishment of a geodetic instrument calibration polygon in the Engure municipality.* To successfully achieve the aim the following tasks for the research were set:

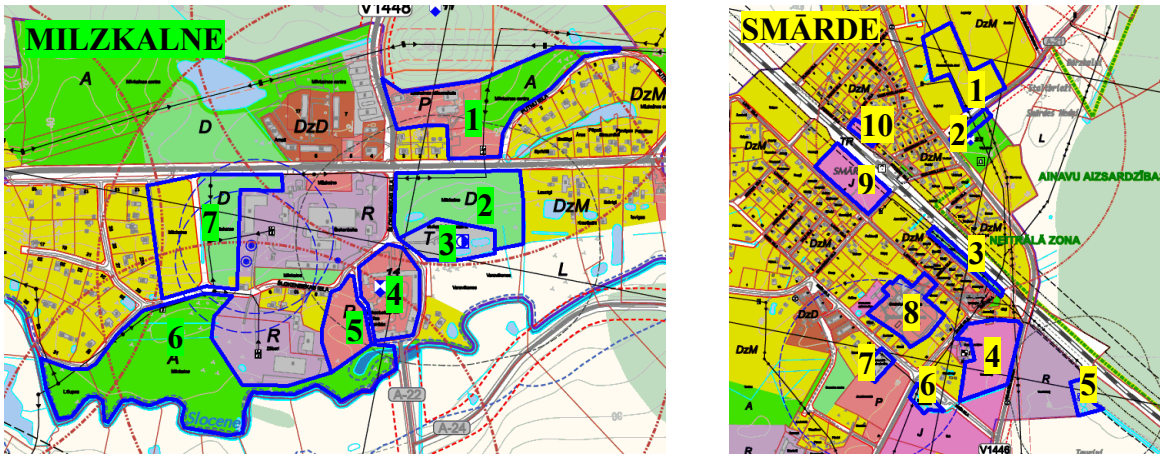
1. to review and summarize the information on calibration polygons and conditions for developing and maintaining open field calibration polygons in literature and regulations in Latvia and other countries;
2. to define the main and most suitable conditions for creating a calibration polygon in the Latvian territory;
3. to explore potential territories and geological data in the Smārde county and to analyse the obtained results;
4. to evaluate the suitability of territories for creating a geodetic instrument calibration polygon.

In cooperation with representatives of the Engure municipality and a few other specialists from the area, the authors of the research participated in exploring the territories in the Smārde county owned by the Engure municipality. The Smārde county of the Engure municipality was considered to be the most suitable for the research based on the findings of researchers Ratkevics (Ratkevičs), Celms (Celms) and Jager (Jäger) as well as the available geological data of this territory. The research of Ratkevics and Celms investigate the requirements to create a geodetic instrument polygon in Latvia

based on polygons created in Scandinavia, Germany, and several other countries over the world (Celms, Ratkevičs, 2011; Ratkevičs, Celms, Jäger, 2015).
The territories were explored by surveying 17 land plots selected previously in cameral works using the cadastral map of the Engure municipality and an orthophoto from 2009, gathering the data for the analysis, and processing and analysing the results of previous research.
The desired surroundings of a territory that would be the most suitable for the polygon was defined based on the requirements for field procedures of testing geodetic and surveying instruments like theodolites, global positioning instruments, electro-optical distance meters (EDM) and levellers described in the international and Latvian standards (LVS ISO 17123-2, 2001; ISO 17123-3, 2001; ISO 17123-4, 2012; ISO/DIS 17123-8, 2014).

Methodology of research and materials

Having analysed the research based on the comparison of the environment, climate, and geology of Latvia and Scandinavian countries (Ratkevičs, Celms, Jäger, 2015), it was clarified that in order to create a calibration polygon successfully the most important condition is that all elements of a polygon (in this future polygon – pylons placed in polygon) need to carry out their designed tasks qualitatively. In order to comply with this condition, the pylons have to be placed and strengthened on a solid and stable rock layer not deeper than 2 metres. If it is not possible to provide such stable and solid base, there is a risk that the pylons will not maintain constant condition or that the construction installation costs and anchorages will be much higher (Ratkevičs, Celms, Jäger, 2015). Having considered these reasons, it is very important to know the geology of a territory where the location of calibration polygon is planned.
Knowledge of geology in the area is based on 11 geological drill holes made in the Smārde village (the centre of the Smārde county) in 2011, where it was discovered that the rock layer of dolomite can be found at a depth from 2 to 4 metres from the land surface (Geotechnical research of.., 2011). The territory of a calibration polygon was planned as close as possible to the Smārde village.
Before the surveying phase, potentially suitable land plots were selected by using a cadastral map of the Engure municipality and an orthophoto from 2009. In total, 17 land plots in the Smārde countywere selected: 7 land plots are located in the Milzkalne village and 10 land plots are located in the Smārde village (Fig. 1).



Source: made by the authors by using the territorial plan of the Engure municipality for years 2013–2025

Fig. 1. Land plots selected for surveying in Milzkalne and Smārde villages

During the survey, the suitability of surroundings was evaluated. Based on the requirements for field procedures of testing geodetic and surveying instruments described in the international and Latvian standards (LVS ISO 17123-2, 2001; ISO 17123-3, 2001; ISO 17123-4, 2012; ISO/DIS 17123-8, 2014), it was decided to observe and note which land plots have less bushes, trees, woods, or buildings which might be disturbed due to the deployment of pylons and which have large and transparent areas. During a visual evaluation of surroundings these observations were made in all 17 land plots. In suitable or partially suitable territories samples of a land in the depth of 1 metre were taken with a soil

probe to find out whether dolomite can be found there closer to the land surface than in drill holes back in 2011.

Discussions and results

The results of surveying 17 land plots in Milzkalne and Smārde villages showed that there were only two suitable land plots (M-2, M-7) in the Milzkalne village and three land plots (S-1, S-2, S-3) in the village. Three land plots in the Milzkalne village and seven in the Smārde village were recognised as partially suitable (Table 1).

Table 1

The evaluation of land areas selected for surveying

No	Land plot symbol	Short describe of an area	Evaluation
1	M - 1	a transparent meadow with several separate trees on W-SW-S, a school in the centre, a forest on NE-E	Partially suitable
2	M - 2	a transparent meadow, a ditch covered with bushes from S to N, garden allotments on W	Suitable
3	M - 3	a meadow with separate bushes on W, building in the centre, pond on SE, bushes on S and E	Partially suitable
4	M - 4	a lawn on S and W, the manor of Šlokenbeka covers the largest part	Partially suitable
5	M - 5	covered with bushes	Not suitable
6	M - 6	thick bushes on S, meadow with separate trees and bushes on N	Not suitable
7	M - 7	a transparent meadow	Suitable
8	S – 1	a transparent meadow, power line from SE to SW	Suitable
9	S - 2	a transparent territory of the recreational park “Garden of Winds” (“Vēju dārzs”)	Suitable
10	S - 3	a meadow with trees and bushes next to a railroad	Not suitable
11	S - 4	a transparent meadow	Suitable
12	S - 5	buildings, many bushes, poor transparency	Not suitable
13	S - 6	a bus stop and bushes in the centre surrounded by meadows	Not suitable
14	S - 7	buildings and bushes	Not suitable
15	S - 8	buildings, few separate trees and bushes	Not suitable
16	S - 9	a meadow with bushes and trees next to a railroad	Not suitable
17	S - 10	a transparent meadow next to a railroad	Not suitable

Source: made by the authors

During the process of evaluating the land plots, 20 samples of the land in the depth of 1 metre were taken with a soil probe in 8 land plots with a suitable or partially suitable evaluation. 5 samples were taken in the land plot labelled M-1, 3 in land plots labelled M-2, S-1, 2-4, 2 in land plots labelled M-7, S-2, and 1 in land plots labelled M-3 and M4. Along with the taken samples, in these points coordinates were measured based on the global positioning method (Table 2). The results of the analysis of these samples confirm that there is a rock layer of dolomite found in the depth lower than 1 m, but it was found only in a single sample point market with the number 17 (coloured in grey, Table 2) in a land plot labelled S-1. But, as it is known, rock layers are not positioned in straight horizontal lines, so even after few centimetres the depth of the layer may be located much deeper, which makes these promising results not very definite and convincing.

Table 2

Coordinates of the points of land samples

No	Land plot symbol	Coordinates	
		x	y
1	M - 1	315300.39	453003.68
2		315310.03	453061.06
3		315249.35	453015.40
4		315236.59	453016.81
5		315222.64	453080.82
6	M - 2	315157.49	453190.01
7		315160.14	453155.68
8		315041.97	452988.14
9	M - 3	314990.21	453085.46
10	M - 4	314192.05	452935.56
11	M - 7	314850.12	452624.17
12		314930.90	452617.74
13	S – 1	312753.61	459891.43
14		312809.59	459935.62
15		312855.70	459931.70
16	S - 2	312918.21	459892.80
17		312982.16	459842.11
18	S - 4	312131.61	460199.59
19		312131.80	460157.64
20		312031.38	460185.45

Source: made by the authors

Due to the foundation of dolomite layer being so close to the land surface in this area, it was assessed that the territory of recreational park "Garden of Winds" and surrounding territories were the most suitable to develop the project, but geology was still unclear. So the promising but unconvincing results of land samples provided the research and analysis of geology base only on the geotechnical research in the Smārde village completed by geological and geotechnical company Ltd. 'BG Invest' on 18th of March and 5th of April, 2011.

Table 3

The depth of dolomite found in drill holes in 2011

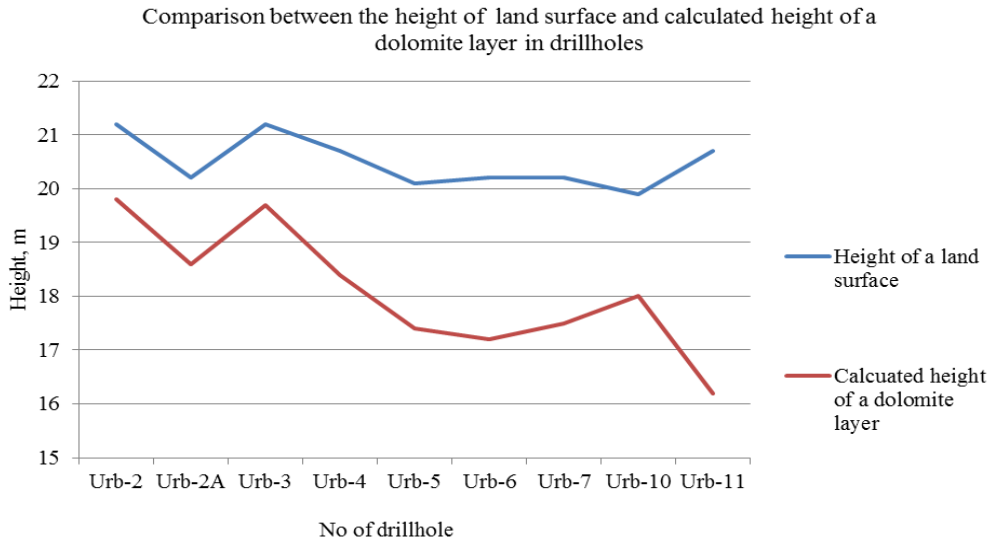
No of drill hole	Absolute height of land surface, m	Lowest rock level			
		Upper depth, m	Lower depth, m	Calculated absolute height, m	Description
Urb-1	21.80	2.3	3.0	-	Moraine clay loam, detailed plastic, brown with water-saturated small sand layers
Urb-2	21.20	1.4	-	19.80	Dolomite rock, moraine clay loam with dolomite chippings and flour from 1.2 m
Urb-2A	20.20	1.6	-	18.60	Dolomite rock, dolomite chippings and flour from 1.4 m
Urb-3	21.20	1.5	-	19.70	Dolomite rock, dolomite chippings and flour from 1.4 m
Urb-4	20.70	2.3	-	18.40	Dolomite rock, dolomite chippings and flour from 1.4 m
Urb-5	20.10	2.7	-	17.40	Dolomite rock, dolomite chippings and flour from 2.5 m
Urb-6	20.20	3.0	-	17.20	Dolomite rock, dolomite chippings and flour from 2.9 m
Urb-7	20.20	2.7	-	17.50	Blue-grey dolomitic marlstones, dolomite chippings and flour from 1.1 m
Urb-8	19.60	1.1	3.0	-	Moraine clay loam, tough plastic, red-brown, from 2.4 m depth with water-saturated small sand layers
Urb-9	20.80	2.4	3.0	-	Clay loam, tough plastic, light brown
Urb-10	19.90	1.9	-	18.00	Dolomite rock, dolomite chippings and flour from 1.4 m
Urb-11	20.70	4.5	-	16.20	Blue-grey dolomitic marlstones, dolomite chippings and flour from 2.9 m

Source: made by the authors from the data in Ltd. 'BG Invest' geotechnical description

The geotechnical research was carried out based on the order by the company Ltd. 'FIRMUS Design and Construction'. This order was completed for the development of a reconstruction project of water collection and production systems and the expansion of a water supply and sewerage system (SIA 'BG Invest', 2011).

Having assessed the location of the drill holes and the depths where the rock layer of dolomite was found in them (Table 3), as well as possessing the only available positive result from land samples, an approximate depth of the dolomite layer in the territory of the recreational park "Garden of Winds" was calculated.

The geotechnical research found that dolomite forms a layer in all drill holes, except the ones labelled No Urb-1, Urb-8, and Urb-9. The layer consisting of dolomite was reached in the depth between 1.1 to 4.5 metres from the land surface, but chippings and other signs were observed even higher, in the depth between 1.1 to 2.9 metres. The location of the dolomite layer is calculated based on the height of the land surface and the depth of the dolomite layer in drill holes, and it varies between 16.20 to 19.70 metres above the sea level in the Latvia Height System 2000.5 (LAS-2000.5), mostly concentrating between 17.50 to 18.50 metres above sea level (Fig. 2).



Source: made by the authors from data in Table 2

Fig. 2. Comparison between the height of the land surface and the calculated height of the dolomite layer in drill holes.

During the research of Ltd 'BG Invest', mainly dolomite chippers forming small layers with few areas of dolomite and dolomitic rock were found in the points on the red coloured line. According to the information provided by the geotechnical bank, under this layer there is a layer of Upper Devonian Salaspils suite rocks (D_3Slp), a semi-hard and hard clay with dolomitic rocks and dolomite. With regards to the stability of the polygon element construction and their connection to the bedrock, the layer of dolomitic rocks and dolomite are the most suitable for the establishment of a calibration polygon in the planned territory.

Conclusions and proposals

1. Currently, there is no geodetic instrument calibration polygon open for everyone in Latvia.
2. To successfully construct polygon elements, it is necessary to know the environment, climate and geology of the territory, because the elements of the polygon need to be stable to maintain itself for a long period of time.
3. Eight land plots selected as potential areas for the polygon were evaluated as suitable or partially suitable, but dolomite was found only in one of them.
4. Out of all the territories that were checked and analysed, the most suitable territory, having met all the requirements, was a territory of a recreational park "Garden of Winds", so it was recognised as the territory where a geodetic instrument calibration polygon should be developed.
5. We propose to fulfil the idea of creating a geodetic instrument calibration polygon.

References

1. About the Comformity Assessment: Law of Republic of Latvia (1996). *Latvijas Vēstnesis* No. 139 (624), 20th of August.

2. About the Measurment Unity: Law of Republic of Latvia (1997). *Latvijas Vēstnesis* No. 69/70 (784/785), 11th of March.
3. Celms A., Ratkevičs A. (2011). Geodetic instrument and technology calibration polygons and base comparators: *Geography. Geology. Environmental science. Thesis of papers*. Riga: University of Latvia, 508 pp.
4. ISO 17123-3: Optics and optical instruments – Field procedures of testing geodetic and surveying instruments – Part 3: Theodolites. 2001.
5. ISO 17123-4: Optics and optical instruments – Field procedures of testing geodetic and surveying instruments – Part 4: Electro-optical distance meters (EDM measurements to reflectors). 2012.
6. ISO/DIS 17123-8: Optics and optical instruments – Field procedures of testing geodetic and surveying instruments – Part 8: GNSS field measurement systems in real-time kinematic (RTK). 2014.
7. LVS ISO 17123-2: Optics and optical instruments - Field procedures of testing geodetic and surveying instruments - Part 2: Levels. 2001.
8. Ratkevičs A., Celms A., Jäger R. (2015). Geodetic Instrument Calibration Polygon Element Structure and Construction.: *Civil Engineering `15,* Volume 5, p.174 -181.
9. Geotechnical research of the base (2011). Project of a reconstruction of water collection and production systems and an expansion of water supply and sewerage system in Smārde village.: Livani, Ltd "BG Invest".

Information about author
Irēna Kukule. Latvia University of Agriculture, Faculty of Environmental and Civil Engineering Sciences, Department of Land Management and Geodesy, Assistant, Bc.sc.ing., Master student. Adress: Akademijas 19, Jelgava, LV-3001, Tel: (+371) 26341953, e-mail: irena.kukule@llu.lv

Armands Celms. Latvia University of Agriculture, Faculty of Environmental and Civil Engineering Sciences, Department of Land Management and Geodesy, Assistant professor, Dr.sc.ing. Adress: Akademijas 19, Jelgava, LV-3001, Tel: (+371) 29131631, e-mail: armands.celms@llu.lv

Vivita Baumane. Latvia University of Agriculture, Faculty of Environmental and Civil Engineering Sciences, Department of Land Management and Geodesy, Professor, Dr.oec. Adress: Akademijas 19, Jelgava, LV-3001, Tel: (+371) 29113347, e-mail: vivita.baumane@llu.lv

THE CURRENT ISSUES OF LAND USE OF TERRITORIES OF GARDENERS' ASSOCIATIONS IN LITHUANIA

Vilma Kriaučiūnaitė-Neklejonovienė[2, 1], Donatas Rekus[2,1] Giedrius Balevičius[1].
[1]Aleksandras Stulginskis University, [2]Kaunas University of Technology

Abstract
The article presents the analysis of the Associations of Gardeners of Lithuania as well as the undergoing changes in their territories. The objective of the article is to discuss the current situation in the territories allocated to the amateur gardens and to assess the current issues concerning the land use and management. The associations of gardeners have encountered a great number of problems concerning the territorial planning, engineering communication services and services maintaining the needs of the associations, the expansion as well as development of these areas. The associations of gardeners comprise 216932 individual gardeners; they manage 228673 land parcels owned by them, which occupy 20714 ha.
Key words: Associations of Gardeners, territories of the amateur gardeners.

Introduction

Previously, the residents of towns and cities used to choose the territories for collective gardens with an intention of having a rest or spending leisure time. However, over time due to the rising accommodation prices the citizens started purchasing plots of land in the territories of collective gardens or gardeners' associations with the intention of building a single-family house or renovating the existing one. At present, the gardeners' associations, especially those located close to towns and cities or in urban areas of towns, do not resemble the former areas of the collective gardens. The collective gardening in Lithuania is considered to have started in 1959 (other sources state that it begun in 1949), i.e. when the Association of Gardeners of Lithuania was established (LAG) (Kauno..., 2015).

In accordance with the valid present Law on the Associations of Gardeners (2004), the Association of Gardeners (A/G), which include amateur gardening is defined as 'a *limited liability, non-profit public entity, the purpose of which is to implement the general rights and obligations of the gardeners in terms of management, maintenance and usage of the territory and the structures as well as objects located in the territory of the amateur garden'*. The territory of amateur garden consists of a land parcel owned by the gardener or by other persons; it, as well as the land, which is allocated for common use of the gardeners and the establishment of collective gardens according to legal acts, later specified project on the property rights of land or territorial planning documents, is managed in accordance with the property law or other rights. The working group analysed and singled out the most relevant problems of the associations of gardeners (Tarpžinybinė…, 2013). Thus, it is obvious that the substantial problems prevailing in the associations of gardeners concern their territorial planning, engineering services, maintenance of services, expansion and the development of such territories.

The objective of the article is to discuss the current situation in the territories allocated for the amateur gardens and to assess the current issues concerning land usage and management.

Methodology of research and materials

When collecting the information there were analysed the official reports, speeches at conferences, scientific articles and publications on urgent problems and issues of the amateur gardens made in the associations of the gardeners of Lithuania. The research used the statistical data obtained from the National Land Service (NLS) at the Ministry of Agriculture (AM) and the information on governmental institutions available at Centre of Registers (CR).

The prepared questionnaire was placed on the Internet (at the beginning of 2015). 60 municipalities and 48 territorial experts of NLS were surveyed. All the regions participated in the survey. The greatest number of questionnaires was presented in Kaunas, Jurbarkas, Klaipėda and Varėna region. The participating experts on territorial planning and geodesy, comprised 50% of the total number of the participants.

Discussions and results

The land of amateur gardens is managed by 1800 associations of gardeners; 1320 public entities are registered in the Register of Legal Entities (Juridinių…, 2015). More than 26% of the associations

have not been registered or their registration is no longer valid. Number of registered A/G per administrative unit is presented in in figure 1.

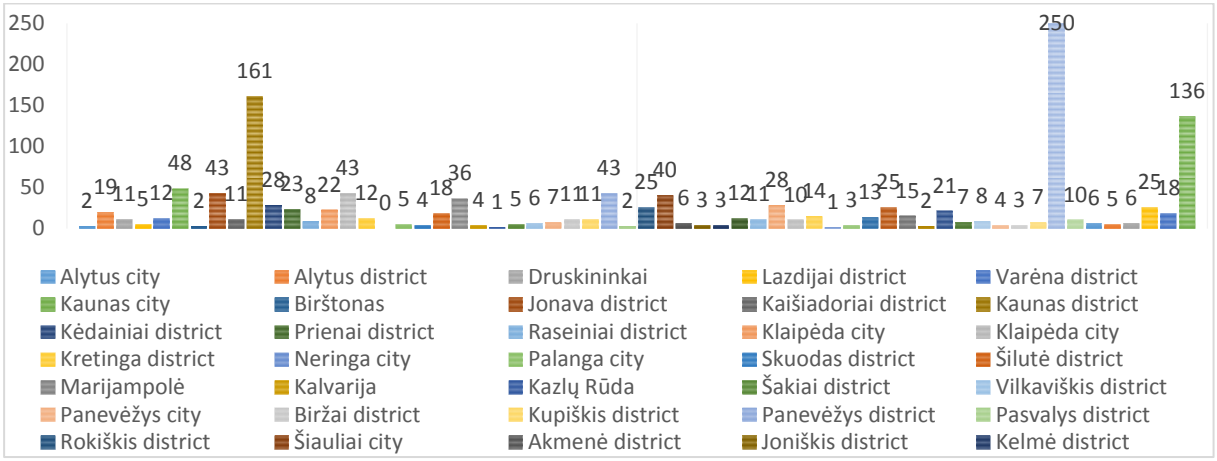


Fig. 1. Number of registered A/G per administrative unit (prepared by the Register of Legal Entities)

The land of the amateur gardens as well as the land for common use owned by the association of gardeners is considered (Lietuvos…, 2004) to be agricultural land. The private owned land of members of the A/G comprises only a minor part or 0.43% of the privately owned land, but the state land used by the gardeners occupy only 1.11% of the state-owned agricultural land. 216932 gardeners of A/G manage 228673 land parcels of the amateur gardens, which occupy a total area of 20714 ha and use 0.53% of the total agricultural land. The largest part of gardens have already been privatised, table 1 presents the change of its users during five years.

Table 1

Changes among the users of privately owned land in A/G

Years	Number of Owners/Users	Total area, ha	Agricultural land, ha	Roads, ha	Developed territorial areas, ha	Other land, ha
2010	201131	14256.61	13533.26	0.85	503.14	211.18
2011	202403	14328.73	13458.19	1.02	650.83	209.44
2012	203346	14383.08	13370.84	1.26	793.08	206.55
2013	204052	14438.22	13217.54	1.93	1002.72	201.63
2014	204621	14575.20	13106.44	36.08	1199.15	198.05

During the investigated period there was observed a tendency for the increase of number of members of the A/G as well as the area of land. During the period of five years, 3490 gardeners obtained their land, which comprised 318.59 ha by making payments to the state; the most active purchase of land from the state was observed in 2013. During the recent years there were privatized 136.98 ha of the amateur garden land. During the research study *the area under the farm land* had a tendency to decrease significantly, especially in 2013, when the purchase of garden parcels increased. Since 2010, the total area has been reduced by 426.82 ha. It is possible to make an assumption that the gardeners have performed such activities, which are not typical for the amateur gardening on the privately owned land parcels. The tendency to use gardens as the permanent place of residence as well as the exponential increase of the developed territorial areas of the land of A/G was observed. During the last five years (till 2014), *the number of the developed land* increased by 696.01 ha, and during the last years it comprised 1199.15 ha. The maintenance services for residential areas by roads increased as well, thus since 2010, the areas allocated for roads were expanded 35 times. The increase of the above mentioned territories was caused by the registration of the existing roads in the territories of A/G, namely by performed cadastral surveying and registration in the Register of the Real Property. During the analyzed period, the *other land* areas were reduced in the territories of A/G.

The geographical differences in the territories of the gardens, diverse recreational potential of the environment, better accessibility, different economical interests and other reasons preconditioned diverse strategies on the development process of the A/G. The experts of the municipalities were asked to determine the possible development trends of the territories of A/G. Actually, 52% of A/G

municipalities are located in the territories where the transitional processes are prevailing and residential areas are developing rather fast. The territories with the majority of the structures of residential purposes were pointed out within the boundaries of the largest cities of Lithuania and the areas surrounding them, namely Klaipeda city and region, Siauliai, Kelme regions, Kaunas city and the surrounding neighborhoods, Vilnius city, Salcininkai region. The citizens declared their place of residence in the garden territories. The territories, which were developed as the recreational ones, had a great number of reconstructed buildings adapted for the permanent residence. The experts singled out nine municipalities typical for the above mentioned ones. 31 % of the gardens under the regulation of the municipalities, where the recreational zones with the structures adapted to the permanent residence prevailed, were located in the periphery of Akmene, Jurbarkas, Pakruojis regions and in the Lakeland regions such as Telšiai, Silale, Utena, Lazdijai, Varena. In Marijampole municipality the inhabitants preferred gardens both for recreational and for leisure purposes. There was observed the fact, that there remained only very few gardens where traditional gardening was used for the agriculture produce. To such territories there were allocated only 10 % of the municipalities. Kėdainiai, Širvintos and Zarasai regions had gardens without structures or their design was not complicated. The experts of the municipalities of Raseiniai and Biržai regions did not present specific tendencies concerning the expansion and development in the amateur gardens mentioned above.
It is possible to make an assumption that the territories of the gardens, especially those located in the outskirts of large cities of Lithuania, exhibit the transition into the type of gardens used for residential purposes. While at present the recreational potential is prevailing in allotment gardens, in the nearest future, they tend to become residential areas (Atkocevičienė, 2013).
The problems in the A/G submitted to the experts for assessment (Kurtinaitytė, 2015). Fig. 2 shows the assessment of prominent issues in amateur gardens.

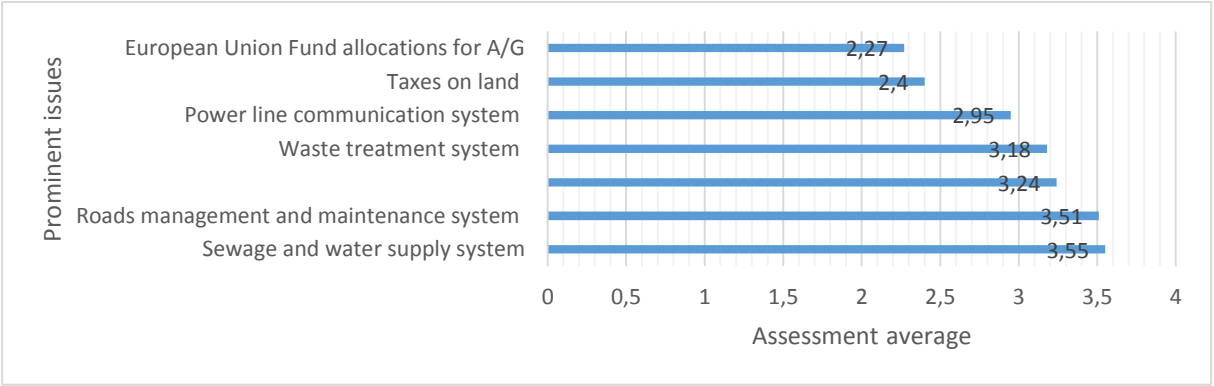


Fig. 2. Assessment of the relevant problems in the amateur gardens

The most prominent issue is *water supply, waste management and treatment system*. The assessment provided by the experts confirms the issue; they define this problem as the most important one. The expansion of the construction works in the territories of the gardens has caused an increased amount of sewage discharge into water reservoirs, trenches or forests; a certain amount of sewage was collected into the sewage pits. The gardeners themselves were responsible for that (Sodininkų…, 2013); they used to keep maintenance of the sewage themselves, therefore, there appeared the necessity to provide waste and sewage treatment systems in the territories of A/G.
The second urgent and important issue is the allotment gardens having to deal with *road management and maintenance*. The length of the internal roads under the regulation of the A/G in Lithuania was about 15,000 km (Savivaldybėms..., 2012). In accordance with the Law on Allotment Gardens, municipalities were obliged to cover and compensate payments made for cadastral measurements and their registration, if they were obliged to take over the internal roads of the allotment under their regulation (Lietuvos..., 2004). The gardeners found the amendment of the law an appealing one. The experts reasonably underlined the problems of road maintenance. Because currently the roads of the A/G are too narrow and do not satisfy the requirements set for local roads, issues concerning their registration in the Real Estate Register continuously follow. The boundaries of roads are planted with trees, which make it difficult to perform cadastral measurements; at the edges of the roads there are electric lines and there are unwarranted structures on segments of roads. In order to solve the problem of funding the management and maintenance of roads, the Ministry of Environment compiled a questionnaire for municipalities to be able to determine the number of roads under the regulation of

amateur gardens, to define their state and condition as well as the number of roads to be transferred under the regulation of municipalities. Based on the data collected by the municipalities, the government was able to plan the demand and need for funds for 2016 (Savivaldybės..., 2015).
The experts noted that the territories of residential areas dominated the gardens and thus, there were issues regarding *housing construction and violations* of regulations related to them. The experts rated the issue as the third most important in their opinion. Without changing the general purpose of the land parcel of the amateur garden located in the territory, after working out the design and upon receipt of the building permit, it was possible to build and renovate only one single family house and some structures attached to it on the parcel. New structures, not higher than 8.5 m are allowed to be constructed on the garden parcel of 0.04 but not smaller. The territory of the garden and the construction works on the parcel have to be in accordance with the domestic regulations of the A/G; there is a requirement to observe all the prescribed fire safety regulations and not to violate the interests of the owners of the adjacent neighbouring parcels (Statybos..., 2005). No data was received concerning the number of the structures constructed in the territories of the A/Gwhich did not correspond with these requirements, however, it was known that unauthorised constructions on the territories of garden parcels were provided or the structures were not legalised so far.
An urgent problem that requires a solution is *waste treatment* in A/G. Municipal waste collection and disposal services are not always provided properly in the territories of amateur gardens and therefore there are many legal disputes concerning the charges for the municipal waste management and treatment. There is a great number of specific examples when the allotment gardens located within the boundaries or outskirts of the cities sign agreements with enterprises dealing with municipal waste treatment and, as a result, the allotments now have containers of the general or special type (Atliekų..., 2015) for sorting waste.
When analysing and assessing the issues in the amateur gardens, the experts pointed out the problem of land *taxation* and EU *funds misappropriation* concerning the allotment gardens. In accordance with the valid Law on the Allotment Gardens, the land in the territories of amateur gardens allocated for the common usage is not to be taxed. However, each allotment under the general agreement of the members determined the amount of tax for a single member of the allotment gardens. Each allotment applied the tax independently. The collected taxes were used to maintain internal roads, to upgrade and repair water and waste installations, organise cleaning works and voluntary initiatives.
By assessing the prominent issues in the amateur gardens, experts at municipalities specified the fact that the cadastral measurements were intensified for the land plots in the gardens and after the permits were issued for the construction of residential buildings and fences in the territories of the allotments, the number of violations regarding territorial planning increased uncontrollably, which prevented the possibility for the required infrastructure to be developed. The issue of land management in the territories of amateur gardens remains an urgent and relevant one for the majority of the allotment gardens. In order to solve the relevant A/G issues, the chairpersons and the members of the A/G and the allotments themselves actively participate in the discussions held together with the local authorities and governmental institutions.

Conclusions

As the number of the purchases of amateur garden parcels actively increases, the gardeners are confronted with a lot of issues when determining the boundaries of their land parcels using cadastral measurements as well as issues pertaining to a single-family house construction due to which legal disputes are initiated. The research study determined the most prominent issues that gardeners face, such as drinking water supply, sewage discharge, waste treatment, and road network repair and maintenance.
Allotment gardens are organised around large towns and cities as well as in the rural areas of Lithuania with a clearly expressed majority of residential housing and related structures there. The territories of amateur gardens are under an intense transition to become residential areas.
The amateur gardens located on the periphery of Lithuanian regions as well as in the Lakeland regions distinguish themselves by recreational tendency, with prevailing recreational zones and with residential structures for permanent residence. A decrease of allotment gardens is observed in locations where the population still engages in traditional gardening for their own needs and produces agricultural produce on their land parcels.

References

1. Atkocevičienė V., Sudonienė V. (2013). Amateur Garden Land Management and Use. Proceedings of the International Scientific Metodical Conference "*Baltic Surveying 2013"*, p.14-20.
2. Juridinių asmenų registras (2015). [The Register of Legal Entities] Valstybinė įmonė Registrų centras. Available at http://www.registrucentras.lt/jar/p/index.php?pav=sodinink%C5%B3&kod=&sav=163&sta=&for=&p=1 (accessed on 29/01/2015)
3. Kauno susivienijimas „Sodai" (2015). [The Association of Gardeners in Kaunas "Sodai"] Apie Kauno susivienijimą „Sodai". Available at http://www.kaunosodai.lt/apiemus.html (accessed on 26/05/2015).
4. Kurtinaitytė A. (2015). Sodininkų bendrijų teritorijų būklė ir plėtros tendencijos. *Jaunasis mokslininkas 2015*: studentų mokslo darbai (*CD)*.
5. Lietuvos Respublikos sodininkų bendrijų įstatymas (2004). [Law on the Associations of Gardeners of the Republic of Lithuania]*Valstybės žinios*, Nr. 4-40.
6. Lietuvos Respublikos Vyriausybės nutarimas „Dėl Valstybinės žemės sklypų pardavimo ir nuomos mėgėjų sodo teritorijoje".(2004). [Sale and Rent of Public Land Plots in the Territory of Amateur Garden] *Valstybės žinios*, Nr. 167-6129.
7. Lietuvos Respublikos žemės įstatymas (2004).[Law of Land of the Republic of Lithuania]. *Valstybės žinios*, Nr. 28-868.
8. Lietuvos sodininkų draugija **(**2015). [Gardeners Society of Lithuania].Available at http://www.lsdraugija.lt/?page_id=596 (accessed on 14/03/2015)
9. Savivaldybės prašo informacijos apie sodininkų bendrijų kelius (2015).[Municipalities request data about roads to gardeners communities]. Lietuvos sodai. Available at http://www.lietuvossodai.lt/2015/03/05/savivaldybes-praso-informacijos-apie-sodininku-bendriju-kelius/ (accessed on 29/04/2015).
10. Sodininkų bendrijų asociacija (2013).[The Association of Gardening Communities]. Sodininkų bendrijose gausu bėdų. Available at http://sbasociacija.lt/index.php?psl=21035&i=0&d=0&klb=1, http://www.valstietis.lt/Pradzia/Patarimai/Sodyba/Sodininku-bendrijose-gausu-bedu (accessed on 15/08/2015).
11. Sodininkų bendrijų pirmininkų 2014-12-13 d. konferencijos kreipimasis. (2014).[Referral of the Conference Chairmen of Gardeners Associations on 2014-12-13]. Lietuvos sodininkų draugija Kauno susivienijimas „Sodai". Available at http://www.kaunosodai.lt/Konferencijos%20kreipimas%202014%2012%20183.pdf (accessed on 01/05/2015).
12. Statybos techninis reglamentas STR 2.02.09:2005 "Vienbučiai gyvenamieji pastatai" (2005). [Technical Regulation of the Construction STR 2.02.09:2005]. *Valstybės žinios*, Nr. 93-3464
13. Tarpžinybinės darbo grupės išvados. (2014).[The Conclusions of the Interdepartmental Working Group]. Available at http://sbasociacija.lt/index.php?psl=32004&i=0&d=0&klb=1 (accessed on 12/06/2014).
14. Atliekų tvarkymas sodininkų bendrijose (2015).[Waste Management in the Gardeners Communities]. Lietuvos sodininkų bendrijų asociacija. Available at http://www.sbasociacija.lt/ (accessed on 10/07/2015).

Information about authors

Vilma Kriaučiūnaitė-Neklejonovienė. Associate professor, doctor. Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Land and Water Management. Address: Universiteto str. 10, LT – 53361 Akademija, Kaunas. Ph. (37) 752372. Lecturer, doctor. Kaunas University of Technology, Faculty of Civil Engineering and Architecture. Address: Studentų str. 48, Lt - 51367, Kaunas.. e-mail: vilma.kriauciunaite@ktu.lt. Fields of interest: land-use management, real estate managemen,t geodesy, rural development

Donatas Rekus. Lecturer, doctor. Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Land and Water Management. Address: Universiteto str. 10, LT – 53361 Akademija, Kaunas. Ph. (37) 752372. Lecturer, doctor. Kaunas University of Technology, Faculty of Civil Engineering and Architecture. Address: Studentų str. 48, Lt - 51367, Kaunas.e-mail: donatas.rekus@ktu.lt Fields of interest: calibration of geodetic instruments, Height measurements

Giedrius Balevičius. Lecturer. Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Land and Water Management. Address: Universiteto str. 10, LT – 53361 Akademija, Kaunas. Ph. (37) 752372. e-mail: giedrius.balevicius@asu.lt, Fields of interest: land-use management, geodetic instruments, height measurements.

ACCURACY ASSESSMENT OF LEVELLING STAFFS MARKING USING DIGITAL PHOTOCAMERAS

Vilma Kriaučiūnaitė-Neklejonovienė[2,1], Donatas Rekus[2,1], Giedrius Balevičius[1], Gabrielė Šuliokaitė[1].
[1]Aleksandras Stulginskis University, [2]Kaunas University of Technology

Abstract
The article analyses the determination of accuracy of code levelling staff edges by using their digital photos. The accuracy of the position of graduated lines of levelling staffs is established by comparing reference and test digital photos of levelling staff stored in digital photo camera or in a computer memory. In this case, the position of lines of a calibrated levelling staff is compared to the position of lines of a photogrametric image of a reference levelling staff. Firstly, the digital camera calibration is performed. The aim of the research is to perform the analysis of accuracy of levelling staffs marking's edges by applying lenses of different focal length and to determine which of them provide the most accurate results of calibration. Digital photo camera *Canon-EOS-7D,* with which digital pictures of levelling staffs scales marking were taken, was chosen for the research and calibrated. The pictures of levelling staffs scales marking were taken with different camera lenses (20, 50 mm) and with different camera modes *(auto, macro)*. Having analysed the obtained results, it was assumed that the focal length of lenses of a photo camera and partially the choice of a camera mode have an influence on final results of calibration. The most accurate results were obtained by taking pictures and calibrating the levelling staffs scales with a 50 mm fixed-focus camera lens.
Key words: levelling staffs, calibration, error, digital photo.

Introduction

As the modern geodetic measurement equipment progresses, a microprocessor built-in digital levels captures levelling gauges and the sequence of actions, according to a chosen program, in this way eliminating errors made by a person performing measuring activity by 100%. However, other sources of error, which must be additionally analysed, occur. It might be errors of code levelling staffs scales marking. They might occur due to fault in manufacturing and due to operating conditions of levelling staffs. When working outdoors, they are effected by humidity, sudden changes in temperature, intense solar radiation, mechanical shocks and loads. Due to these reasons, levelling staffs must be periodically calibrated. Presently used interferometric devices for calibration of levelling staffs are complicated, expensive, big, and the process of calibration takes a long time. This could be avoided by using photometric calibration of levelling staffs.

The results of levelling are obtained with unavoidable errors which might be resulted by the equipment used, the environmental impact or the person performing levelling. In order to obtain reliable levelling results, the equipment must be calibrated. New calibration methods, calibration equipment based on flexible digital technology and simple calibration technology are necessary for improvement of calibration of levelling staffs. This would ensure timely control of levelling staffs quality, would allow to control and eliminate systematic errors in levelling which result from errors of graduation of scales of levelling staffs.

Each element of matrix of digital images is called pixel, which means the area of raster cell. (Robinson et al., 1995., Linder 2006). Their significance also depends on the qualities of a registered piece of equipment and (or) of software. When the pixel significance is 0 - completely black; when it is 225 - white (Richards et al., 2006). A relevant configuration stand with marked points is used during the calibration of a photo camera. Photos of a prepared calibration stand are taken horizontally and vertically, the calibration parameters of a photo camera are obtained by solving (Abraham, 2004; Visockienė, 2007) polynomials.

The aim of the research is to perform the analysis of accuracy of levelling staffs marking's edges by applying lenses of different focal length and to determine which of them provide the most accurate results of calibration.

Methodology of research and materials

Photometric calibration of levelling staffs marking's edges is based on application of elements of matrix of digital images.. These methods are used to change the characteristics of digital photos and the points in digital images are recognised by principles of computer vision. Each element of matrix of

digital images is called pixel (a pixel is a picture element), which means the area of raster cell. When the area of element is very small, pixels are called dots (Linder 2006, Robinson 1995).
When performing photometric calibration, special parameters of a digital photo camera must be checked first, its distortion parameters must be determined. The photo camera *Canon-EOS-7D* used for the research was calibrated with the demo version of *PhotoModeler* software. A template of software package presented in Fig. 1 was used for calibration.

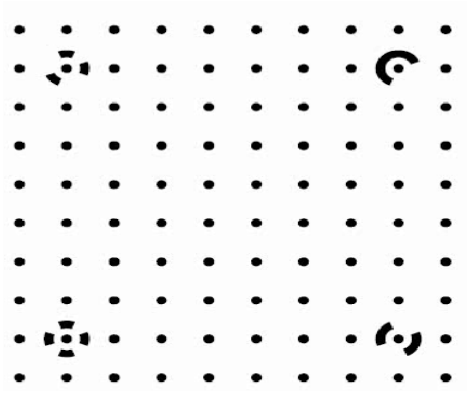


Fig. 1. *PhotoModeler* photographed template

This template is fixed on a horizontal surface, so that it could not be moved when taking pictures. The pictures of the template were taken eight times, from all four sides. First four photographic images were taken horizontally, at 90° angle, the rest when rotated vertically. Having taken pictures of the template, the calibration was started by using Photomodeler software. It is advised to take 6-12 pictures for calibration. In this research, eight digital photographs were used.
Different fixed-focus lenses (20 mm, 50 mm), different distances from levelling staffs and different position of taking of pictures (horizontal, tilted) were chosen when taking photographs.
The parts of pictures of levelling staffs were converted to digital information by means of PIKSELIS software. 21-bit digital photography format was used in this research.
Having carried out the analysis, the results of accuracy were analysed by applying the comparative analysis method. The differences of obtained results were compared with each other and shown in a graph.

Discussions and results
The decision to take pictures with different camera lenses (20 mm and 50 mm) was taken during the research. 21-BMP bit format was chosen for determination and analysis of levelling staffs marking's edges.
Comparison of Pixel values of 20 mm (green), 50 mm (blue) lenses of code levelling staff of the obtained results are presented in figures 2 - 3.

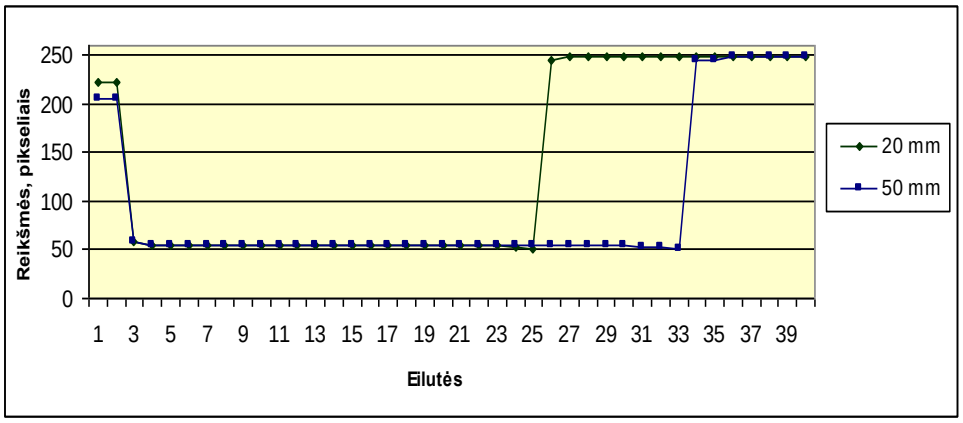


Fig. 2. Fragment values of coded scale (1) by means of 20 mm and 50 mm camera lenses

Figure 2 represents a fragment of a coded scale (1), when pictures are taken horizontally. It can be noted that darker colour captured by a 50 mm camera lens in lines 1 - 2, does not have a significantly

noticeable defect in lines 3 - 25. Starting from lines 26 - 33, it can be noticed that 20 mm camera lens captures a lighter colour, when 50 mm camera lens captures a darker colour.

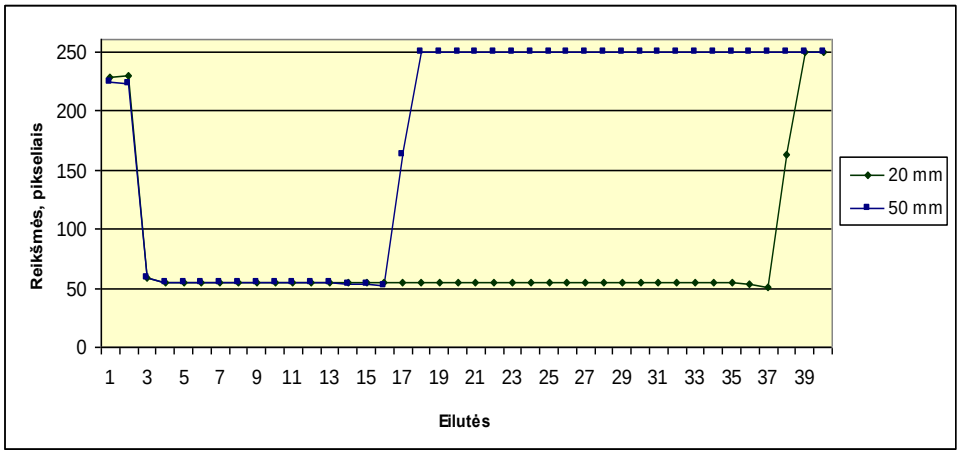


Fig. 3. Fragment values of coded scale (2) by means of 20 mm and 50 mm camera lenses

Figure 3 represents a fragment of a coded scale (2), when pictures are taken in a titled position. It can be noticed that a slight difference is visible in lines 1 - 3, a 50 mm camera lens captured a darker colour; it was not distinguished in lines 4 - 16, which means that a 20 mm and a 50 mm camera lenses recognise the same colours; a significant difference appeared in lines 17 - 38, which shows that a 50 mm camera captured white colour and a 20 mm camera captured a darker colour.

By using the obtained results, we determine the bandwidth of levelling staffs marking's edge, scratchings or other damages which will be relevant for further calibration of levelling staffs.

Other results were obtained by using a *Nikon* digital photo camera. A *Nikon* has a variable focal length camera lens, which a *Cannon* does not have. Different camera modes were used than before with a *Canon*. Several camera modes were used here (*auto* mode, *macro* mode, *portrait* mode) in order to facilitate the process of distinguishing between lighter and darker colours markings.

Figure 4 represents fragments of code levelling staffs scales marking 21-*BMP* digital format, photographs were taken by using different camera modes (*auto* (a), *portrait* (b) and *macro* (c).

a (*auto*) b (*portrait*) c (*macro*)

Fig. 4. 21-BMP bit fragments of code levelling staffs scales marking by using different camera modes

Obtained results of pixel values of code levelling staff in *auto* mode is represented in green, *macro* mode - in blue, *portrait* mode in red (Fig. 5).

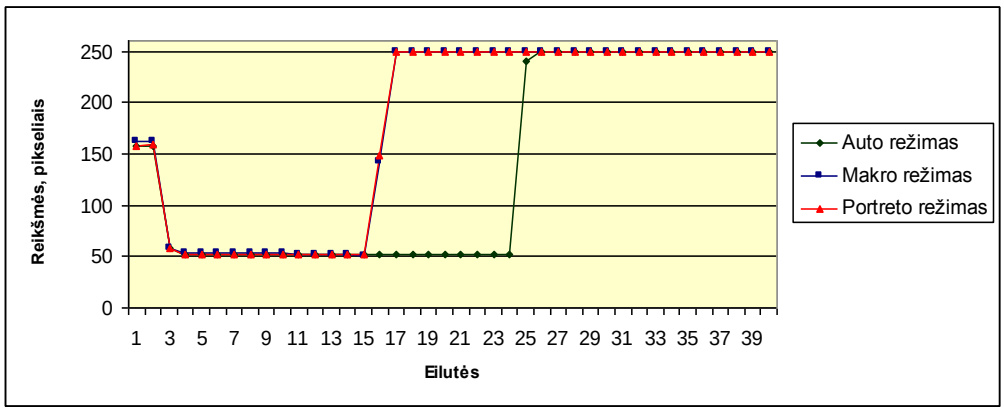


Fig. 5. Code scale's fragment values in different modes

The obtained results of a code levelling staff (fig. 5) show that *macro* and *portrait* modes are relatively equal, the *auto* mode distinguished itself in lines 16 -25. It is known that *macro* and *portrait* modes focus precisely on the object which is being photographed and that they blur the background. *Auto* mode captures a darker colour.
Numerical values (the lowest, the highest) are presented in Table 1.

Table 1

Numerical values of levelling staffs

Image No.	Camera lenses/Camera modes	Values	
		Lowest	Highest
Coded scale (1)	20 mm	51.00	249.475
	50 mm	50.775	249.35
Coded scale (2)	20 mm	54.4	249.325
	50 mm	54.2	249.2
Coded scale (different modes)	Auto	51.25	249.575
	Macro	51.1	249.675
	Portrait	52.5	249.125

Having analysed variants of levelling staffs images processing, it was found that operational and other damages of levelling staffs scales markings can be seen when taking pictures by using different camera modes (or) camera lenses. Inacurracies are different because each camera mode and (or) camera lens have their own specifics when taking pictures.
The comparison of assessment of accuracy of calibration of levelling staffs markings is presented in a graph. The comparison was performed by using the results obtained from pixel values of a code levelling staff. The initial results were obtained by taking pictures with a *Canon EOS-7D* photo camera and its two camera lenses (20 mm and 50 mm).

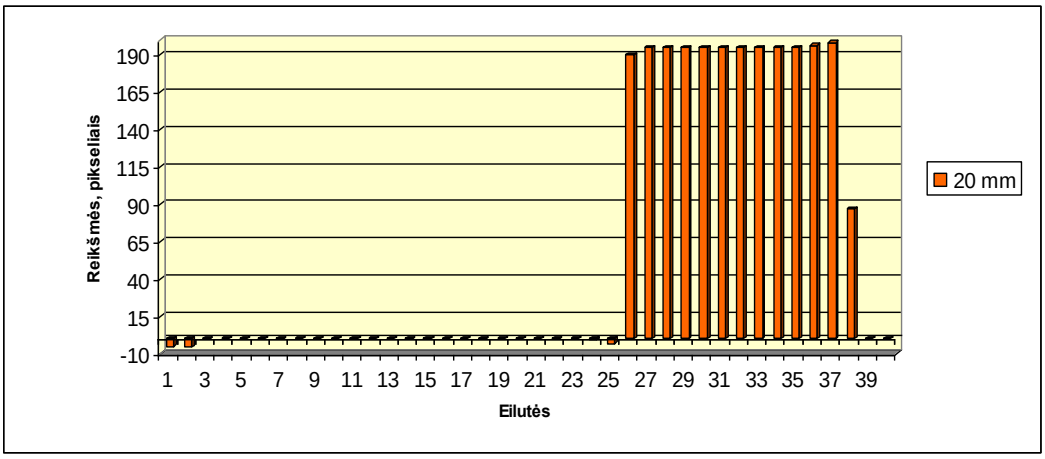


Fig. 6. Numerical values of 20 mm of a coded scale (1, 2)

Having assessed the results of pixel values of coded scales lines, having taken pictures with 20 mm lens camera, having taken pictures in different positions, and by means of photometric calibration, the assessment of accuracy in figure 6 shows that there is a slight difference in lines 1-3, lines 4-26 did not distinguish, and the biggest positive difference is visible in lines 27-39. The biggest difference is 198.275. This difference shows that when taking pictures horizontally, more operational scratches and (or) other changes in coded scale are captured.

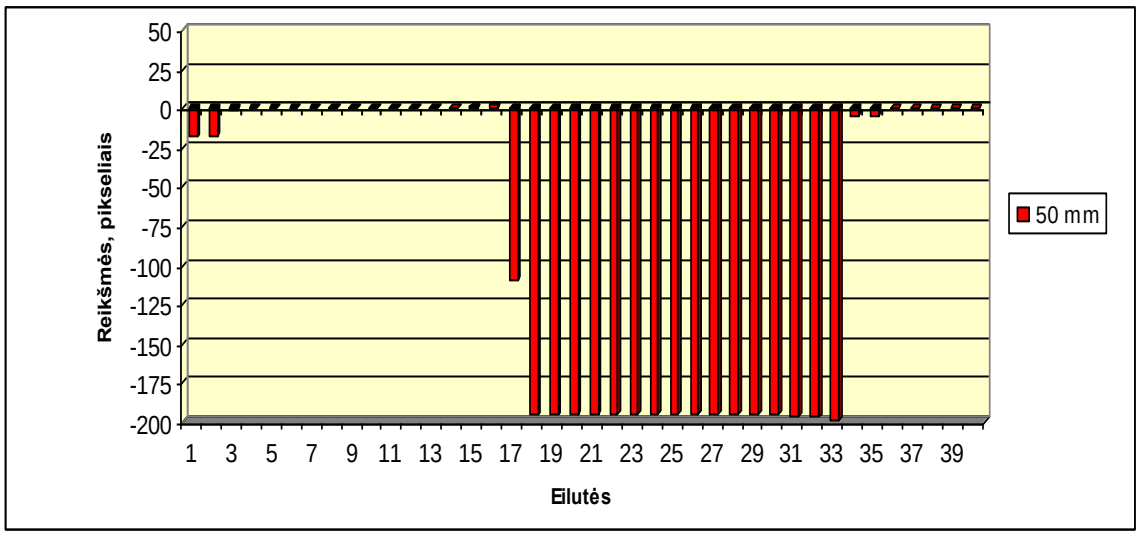


Fig. 7. Numerical values of 50mm of a coded scale (1, 2)

Having assessed the results of pixel values of coded scales lines, having taken pictures with 50 mm lens camera, having taken pictures in different positions, and by means of photometric calibration, the assessment of accuracy in figure 7 shows that there is a slight change in lines 1-3, there are no changes captured in lines 4-16, and the biggest negative difference is visible in lines 19-34. Their biggest negative difference - 195.95, which shows that when taking pictures in a titled position, more operational scratches and (or) other changes are captured.

Different results were obtained when taking pictures with a *Nikon* photo camera and its different camera modes. The results were discussed by means of pair analysis method. It is important to note that this camera has a variable focal length camera lens, contrary to the results obtained with a *Canon* photo camera.

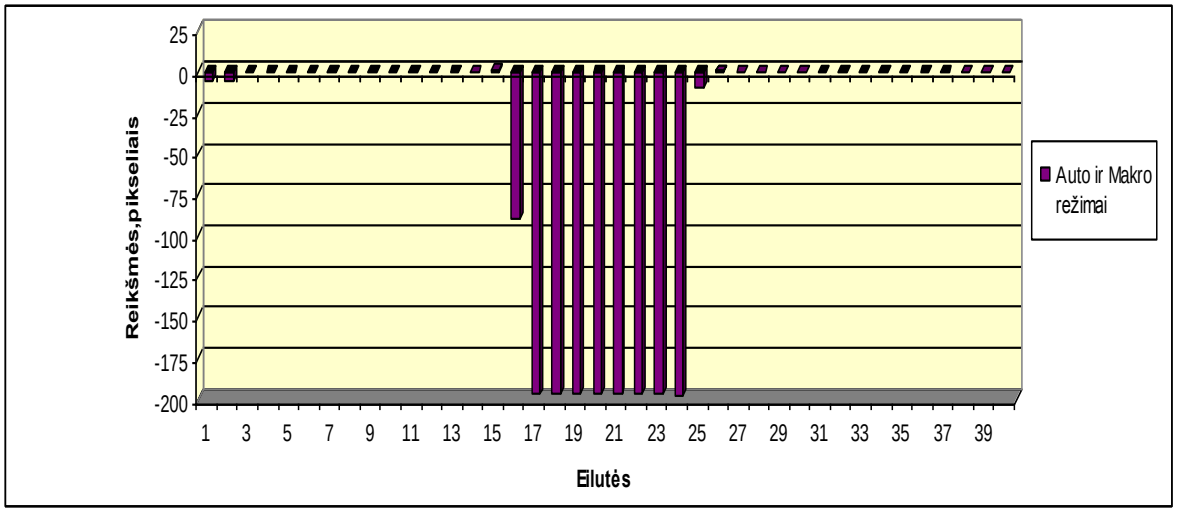


Fig. 8. Numerical values of a coded scale in *auto* and *macro* modes

Figure 8 shows results obtained after having performed the assessment of the results of pixel values of coded scales lines when taking pictures by using different camera modes, in this case in *auto* and *macro* camera modes, and by means of photometric calibration; the assessment of accuracy shows that there is a significant negative difference. Lines 1-3 show minimal scratches and (or) damages captured. Lines 4 - 16 show that when taking pictures in *macro* mode, more lighter colour is captured in darker colour. Lines 17 - 26 show that *auto* mode captured more darker colour than *macro* mode. Slight differences are captured in lines 27-40. The results of the research allow us to make an assumption that when taking pictures in *macro* mode, damages or scratches of a levelling staff are captured. The biggest negative difference – 197.775.

When performing experimental assessment of accuracy of levelling staffs margins by applying the photometric method, the most important thing is to choose the most appropriate focal length of lenses of a photo camera and relatively – camera modes.

Conclusions

When applying the proposed calibration method, the calibration equipment is composed of a digital high resolution photo camera (no less than 8 million pixels), a computer and software designed for describing the photographic view of levelling staffs scales marking in a digital format and for the processing of the obtained information.

Having performed photometric calibration of levelling staffs using a digital SLR 20 and 50 mm fixed focus lenses photo camera *Canon EOS-7D,* by using different camera modes, we can claim that in this kind of calibration it is important to determine the limit between lighter and darker colours marking. This calibration method allows us to attribute numerical values to pixel values of digital photographs of the position of levelling staffs margins, which allows us to determine and assess damages and scratches made to levelling staffs scales.

Having performed the assessment of accuracy of calibration and analysed the obtained results (excluding various conditions of lightning and attachment of levelling staffs) we can claim that the focal length of a camera lens and partially camera modes have an influence on final results.

The most accurate results of calibration were obtained by taking pictures of levelling staffs scales with a 50 mm fixed camera lens.

References

1. Abraham S. Tcc. 2004. A software for Test field based on self-Calibration of multi Camera-Systems. Institute für Photogrammetrie, Universität Bon, 39 p.
2. Krikštaponis B. 2000. Matavimų analoginiais ir skaitmeniniais nivelyrais tikslumo tyrimai. *Geodezija ir kartografija.* Volume 26, Issue 2, 69 – 72 p.
3. Krikštaponis B. 2001. Precizinio niveliavimo paklaidos ir jų įtaka matavimų rezultatams. Iš Kvalifikacinio mokslo darbo ataskaitos. Vilnius, 60 p.
4. Krikštaponis B. 2002. Skaitmeninio nivelyro Wild NA3003 atskaitos sistemos ypatumų tyrimai. *Geodezija ir kartografija*. Volume 28, Issue 2, 39–44 p.
5. Linder W. 2006. *Digital photogrametry*. Berlin:Springer–Verlag. 214 p.
6. Robinson A. H.; Morrison J. L.; Muehrcke P. C.; Kimerling A. J.; Guptill S. C. 1995. Elements of cartography. USA: John Wiley and Sons. 674 p.
7. Richards J.A.; Xiuping J. 2006. Remote sensing digital image analysis. Berlin: Springer – Verlag. 439 p.
8. Sužiedelytė-Visockienė J. 2007. Skaitmeninės matuojamosios fotokameros kalibravimo parametrų įtaka nuotraukas transformuojant į plokštumą. *Geodezija ir kartografija*, Volume 28, Issue 1, 26–30 p.

Information about author

Kriaučiūnaitė-Neklejonovienė Vilma. Associate professor, doctor. Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Land and Water Management. Address: Universiteto str. 10, LT – 53361 Akademija, Kaunas. Ph. (37) 752372. Lecturer, doctor. Kaunas University of Technology, Faculty of Civil Engineering and Architecture. Address: Studentų str. 48, Lt - 51367, Kaunas. Ph. 8(37) 300479. e-mail: vilma.kriauciunaite@ktu.lt

Rekus Donatas. Lecturer, doctor. Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Land and Water Management. Address: Universiteto str. 10, LT – 53361 Akademija, Kaunas. Ph. (37) 752372. Lecturer, doctor. Kaunas University of Technology, Faculty of Civil Engineering and Architecture. Address: Studentų str. 48, Kaunas. Ph. 8(37) 300479. e-mail: donatas.rekus@ktu.lt

Balevičius Giedrius. Lecturer. Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Land and Water Management. Address: Universiteto str. 10, LT – 53361 Akademija. Kaunas. Ph. (37) 752372. E-mail: giedrius.balevicius@asu.lt

Šuliokaitė Gabrielė. Master student. Aleksandras Stulginskis University, Institute of Land Management and Geomatics, Faculty of Land and Water Management. Address: Universiteto str. 10, LT – 53361 Akademija, Kaunas. Ph. (37) 752372.

SWOT ANALYSIS OF LAND CONSOLIDATION PROJECTS IN WESTERN LITHUANIA

Edita Selmonė, Midona Dapkienė, Jolanta Valčiukienė
Aleksandras Stulginskis University

Abstract
The aim of this article is to distinguish strengths and weaknesses of land consolidation process, as well as to find out the opportunities of this process, and the threats which prevent the successful development of land consolidation process.
With the purpose to achieve the goal, the SWOT analysis of five land consolidation projects in Western Lithuania was carried out. It was determined that the main weaknesses of the projects examined are as follows: land consolidation process involves only planning, and not the final clearing-up work of a territory; low activity of landowners; limited opportunities of some interested persons, who wish to participate in the process. Strengths are distinguished as follows: better conditions for the development of rural infrastructure; competitive agricultures are being formed; new jobs; a system of rational land use is being created; sustainable development is being planned. The majority of opportunities are linked with the influence of land consolidation project on other areas, i.e. areas that are not directly related to the result that land consolidation project aims at. Threats occur due to the fact that the authors of projects only copy the regulating provisions of land consolidation projects and do not get into a more comprehensive interpretation of norms of these provisions. Moreover, they do not give details on their analysis, interpretation, or at least their preliminary assessment. In a SWOT context, land consolidation projects prepared in Western Lithuania, are analogous to other land consolidation projects carried out in Lithuania.
Key words – land consolidation, SWOT.

Introduction

Scientific resources describe land consolidation as an instrument which ensures the development of rural areas and increases the efficiency of land use (Sklenicka, 2006). Land consolidation is important in the fight against erosion of rural landscape (Mihara, 1996), in the rationalisation of urban development (Gonzales et al., 2004), and in solving various social and economic development problems of rural areas (Sklenicka, 2006).
In many European countries, land consolidation has been carried out for a long time. Western European countries are counted for almost 200 years of experience, and there is no need to prove the benefits of land consolidation any more. The experience of old European countries has shown that every land consolidation project is closely linked to the rural development and usually combines the following key aspects: reduces land fragmentation, improves their form and location in the area, expands the size of the area itself, improves protection of the environment, development of infrastructure, and appeasement of public interests. However, land consolidation projects in Western European countries were in progress for different reasons (Vitikainen, 2004), using different techniques, thus, different results were achieved.
The conveyance of experience acquired in Western countries to Eastern and Central European countries is not that simple, and sometimes even impossible (Van Dijk, 2007).
Land consolidation issues in Eastern and Central European countries cause more problems, because they are affected not only by naturally occurring land use changes and changing land ownership forms. The most important problem identified is ideological processes (collectivization, development of planned agriculture, etc.) (Roose et al., 2013; DiFalco et al., 2010; Sklenicka, 2006; Sklenicka et al., 2014; Lisec et al., 2014). In the beginning of the reconstruction of Eastern and Central European countries, the entire existing legal framework had to be changed, and land consolidation regulation had to be introduced in the first place.
Land consolidation is beneficial not only to farmers, but also to sustainable development of rural regions. Lithuania is an agricultural region, in which long-standing agricultural traditions have been long valued and cherished. In addition to social problems (unemployment, migration, education, and a lack of necessary skills), there are many other phenomena hindering the competitive ability and efficient agricultural formation of rural regions. First of all, it is an inappropriate landholding structure, prevailing small, scattered and badly structured farms, unsuitable infrastructure for agriculture.
The restitution of land ownership that started after the Restoration of Independence, has led to the problems of land fragmentation. The average size (12 ha) of farms restored in the restitution process, is below the average of the size of the farm of pre-war in 1939 (Pasakarnis and Maliene, 2010).

However, the problems were addressed only in around 2000, and the first legal steps were taken only in 2004 when the Seimas of the Republic of Lithuania adopted amendments to the Law on Land.
The first land consolidation projects in Lithuania were launched in accordance with a Danish - Lithuanian pilot bilateral project in Dotnuva (Kedainiai district) in the period from 2000 to 2002. In 2005, based on this experience, Lithuania launched a national land consolidation programme, during which 14 land consolidation projects, financed by the European Union Structural Funds were carried out since 2006.
After 2010, land consolidation preparation procedures, which even to this day cause a number of problems, were significantly changed. The reformed laws of the period from 2010 to 2013 contain a lot of changes, however, a number of problems still exist (Gulevičienė, 2006). The experience of already drafted projects has a significant influence, however, miscommunication and hostility between professionals and people, cause a number of problems.
It is important to consider not only the theoretical model of land consolidation project implementation, but also the main aspects related to the practical implementation of these projects, which on the one hand pose difficulties to persons drafting and implementing projects, and on the other hand, may be considered to be the positive elements of such projects.
The aim of the work is to carry out the strengths, weaknesses, opportunities and threats (SWOT) analysis of selected land consolidation project training in Western Lithuania.

Methodology of research
The implementation of land consolidation projects is a complex instrument, and in order it to be implemented, it is necessary to evaluate a number of important elements, such as: legal regulation, infrastructure development and its development plans, many of the environmental, cultural, and landscape protection elements, and thus it is necessary to achieve that the practicable project will meet the aim of land consolidation project, i.e. plots of land will be consolidated in a way to satisfy interests of land owners (mostly farmers). Such land consolidation should increase the productivity of landed property, improve the quality of farming, and make these processes more efficient, requiring low cost, but at the same time providing more benefits.
The strengths, weaknesses, opportunities and threats (hereinafter SWOT) analysis of five land consolidation projects in Western Lithuania was carried out. The aim of the analysis was to distinguish strengths and weaknesses of land consolidation process, as well as to find out the opportunities of this process, and the threats which prevent the successful development of land consolidation process. The analysis was carried out in accordance with the classical SWOT analysis model, which distinguished the criteria mentioned above (i.e. strengths, weaknesses, opportunities, and threats). However, it is done depending on specifics of a particular project and if necessary, highlighting and emphasizing such project elements, which, although not fully correspond to the classical SWOT analysis model (i.e. presumably, “misfits” to those four mentioned criteria), however, are still important in regard to the particular project and must be at least briefly discussed in this work. Several specific land consolidation projects carried out/being carried out in different regions of Western Lithuania were selected. This is done in order for the analysis to reflect the results in the most comprehensive and widest scale way and would let to have a maximum objective overview of how particularly land consolidation projects are carried out in Lithuania.
Considering each of the selected projects, it was analysed how these projects would presumably affect the rationality of plots of land in the project’s area, as well as how the implementation of particular projects will affect elements (environment protection, cultural heritage, infrastructure, and other objects) associated with the project’s area. Also, it was analysed what kind of changes of legislation of land consolidation projects there could be in order for the implementation of the process of land consolidation projects in Lithuania to be smoother and more efficient.
Five land consolidation projects analysed in this work are as follow:

- The first project – land consolidation project in Upyna and Luokė subdistricts. This is the land consolidation project of Telsiai County, Telsiai district municipality, Upyna and Luoke subdistricts, Kaunatava, Dirovenai and Upyna cadastral areas, villages (and their parts) of Kaunatava, Padvarninkai, Mantvydas, Deguciai, Verteliai, Pakalniskiai, Dirovenai, Užvedare, Naujikai, Zalione, Paskuvenai, Petrikai, and Tetervine.
- The second project – land consolidation project in Saukotas subdistrict. This is the land consolidation project of Sauliai County, Radviliskis district municipality, Saukotas subdistrict, Saukotas cadastral area.

- The third project – land consolidation project in Sidabravas subdistrict. This is the land consolidation project of Sauliai County, Radviliskis district municipality, Sidabravas subdistrict, Vadaktai cadastral area.
- The fourth project – land consolidation project in Skuodas and Mosedis subdistricts. This is the land consolidation project of Klaipeda County, Skuodas district municipality, Skuodas and Mosedis sundistricts, cadastral areas of Lukniai, Dauksiai and Mosedis, villages (and their parts) of Puodkaliai, Kernai, Kulai I, Kulai II, Kubiliskis, Skuodas suburb, Dauksiai, and Virbalai.
- The fifth project – land consolidation project in Zemaičių Kalvarija subdistrict. This is the land consolidation project of Telsiai County, Plunge district municipality, Zemaiciu Kalvarija district, Zemaiciu Kalvarija cadastral areas, villages (and their parts) of Rotinenai, Kubakiai, Bertuliai, Deguciai, Galvyciai, Zemaiciu Kalvarija.

Key data of projects are presented in Table 1.

Table 1

Land consolidation projects

Data	Projects			
	Upyna and Luoke subdistricts	**Sidabravas subdistrict**	**Skuodas and Mosedis subdistrict**	**Saukotas subdistrict**
Total area of the project (ha)	1698.75	1815.67	985,36	1414.04
The number of participants in the project (pcs)	116	145	227	136
The average size of the plots (ha)	5.23	5.35	5.00	4.25
Plots of land ascribable to the project‘s area (pcs)	325	337	432	333
Area of agricultural land (ha)	1344.26	1572.27	922.20	1367.69
Land of other purposes (ha)	8.86	5.71	17.75	42.08
Plot of land of forestry (ha)	345.64	237.69	35.97	4.04
The average score of agricultural land productivity	38.10	47.20	43.50	40.80
Preliminary measurements performed (pcs)	292	288	356	234
Cadastral measurement performed (pcs)	33	49	76	99

Results and discussion of the analysis

After analysing five general characteristics (a number of participants in the project, plots of land ascribable to the project‘s area, total area of the project, the average size of land after land consolidation projects, and so on) of already examined land consolidation projects in Western Lithuania, the textual part of the projects was consistently explored and the SWOT analysis of these projects was prepared.

Table 2

SWOT analysis of land consolidation projects held/being held in Western Lithuania

Project	Project strengths	Project weaknesses	Project opportunities	Project threats
Land consolidation project of Upyna and Luoke subdistricts	In respect of all areas possibly affecting the project, the impact will be either neutral, or long-term positive.	No assessment about how the preparation and implementation of the project will affect areas indicated in the project regarding the planned tourism	The properly planned construction of power lines and the land consolidation may allow achieving the lowest costs for both processes and the most effective use of the created infrastructure.	In absence of a detailed discussion of the project with interested persons, the implementation of the project (even after completing the process) may be challenged on procedural grounds that the principle of information of interested parties was not followed.

Project	Project strengths	Project weaknesses	Project opportunities	Project threats
		development of Telsiai region in long term.		The failure to comprehensively assess the project impact on the infrastructure related to the power system and telecommunications imposes the risk of the suspension of the project implementation due the negative effect.
Land consolidation project of Saukotas subdistrict	A comprehensive assessment of the possible impact on all areas indicated in the project.	After the implementation of the land consolidation project, the number of road easements will increase almost five times, therefore it is necessary to reconsider the need of these easements.	The properly planned construction of power lines and the land consolidation may allow achieving the lowest costs for both processes and the most effective use of the created infrastructure.	The failure to coordinate the construction of power lines with the land consolidation project imposes the threat of negative consequences to the interested parties.
Land consolidation project of Sidabravas subdistrict	No plans to create energy or telecommunications infrastructure objects in the project area, no plans of urbanization process, no cultural heritage or environmental objects, therefore successful implementation of the project can be expected.	Large area (1815,7 ha) potentially influenced the performance of work, boundaries of the area were changed five times.	It was evaluated and discussed how the implementation of the project will affect the area, i. e. how the land consolidation will potentially affect the priority areas of crop production and sustainable farming.	A part of the project area (Sulneliai, Kaspariskiai) falls into the local geosystem internal stabilization habitats and local migration corridors at river valleys (from Sulneliai through Rudeliai village).
Land consolidation project of Skuodas and Mosedis subdistricts	In the project area it is planned to create only a very localized infrastructure, it is likely that the infrastructure will not adversely affect the land consolidation process and will allow to smoothly implement the project.	There are mounds in the area, which causes difficulty to rationally design land plots near them. Public roads under cadastral regulations divide land plots into separate areas.	No natural heritage objects – possibly will not affect design work and farming efficiency.	Natural frame areas occupy one third of the designed area (geo-ecological divide, geosystem internal stabilization habitats and axles, migratory corridors), and only individual farms are possible in such areas, cases of agricultural conversion are possible only for individual homesteads but not for quarters.

Project	Project strengths	Project weaknesses	Project opportunities	Project threats
	A relatively small number of newly emerging farmsteads will ensure a more efficient asset management and will not cause a negative impact on the project area. In the project area there are no territories reserved for public needs, which reduces the risk of unsuccessful implementation of the project.			
Land consolida-tion project of Zemaiciu Kalvarija subdistrict	The majority of persons (86.5%) involved in the project live in Plunge district municipality, therefore effective meeting can be arranged. Because of the terrain the area is favourable for farming.	A number of specific conditions for the use of land and forest occurred during the implementation of the project, which is likely to affect sustainable farming.	Main persons involved in the project – large farmers – will create better conditions to achieve the goals set.	A part of the designed area fall into the buffer zone, which is likely to affect farming. In Plunge district the system of protected areas (reserves, nature reserves, national parks) occupies 24.3% and more than twice exceeds the average rate of Lithuania, which is likely to affect farming.

Considering the first land consolidation project in Upyna and Luoke subdistricts, it is reasonable to distinguish its positive aspects, which in comparison with others are an advantage to this project and can be viewed as a positive practice. While describing the project's impact on various areas, authors of the project indicated that in principle it will be positive: for the territory development coherence and (or) the planned field of activities; for economic, social and natural environment, landscape and immovable cultural values. However, summing up the evaluation results of the project in SWOT context, it could be stated that it is also reasonable to evaluate the project in the following aspects:

- To assess the rationality of land plots after the implementation of the project, i. e. how farming efficiency will change after the consolidation of land plots.
- To determine whether preparation and execution of the project (in absence of a detailed discussion of the project with interested persons) could be challenged on procedural grounds (i. e. due to the absence of the public consideration of the draft project).
- To analyse whether the planned impact on areas indicated in Telsiai land consolidation project will be positive in all cases (with particular reference to the tourism development in Telsiai region in the long run).
- To fully assess whether the implementation of the project will actually not affect the infrastructure relating to the energy system and telecommunications in the project area. In absence of a more detailed analysis, there is the risk that the disruption of this infrastructure may violate the interests of not only controlling entities or land owners but also of residents of other territories.

Considering the evaluation results of the second land consolidation project in Saukotas subdistrict, it can be stated that some of the statements assessing the impact of solutions are not fully grounded. For instance, the project indicates that:

- "Agricultural activities are being developed in the territory, therefore the implementation of solutions in the planned territory will not cause inconvenience to the residents of the surrounding areas". In this case, it is uncertain how the agricultural development process is directly related to potential inconveniences to the residents of the surrounding areas.
- "The solutions will have a positive impact on the current ambient air pollution level which will not exceed the permissible limit values for the living environment. The land amalgamation will make the land work more convenient". It is incomprehensible how air pollution level is directly related to the possibility "to make the land work more convenient".

The project also stipulates that thirty five road easements were registered prior to the rearrangement of the project area and another six new road easements were designed. It is believed that in the land consolidation projects it is necessary to seek for the relevant constraints (such as easements) to be determined as few as possible.

It can be stated that the third land consolidation project in Sidabravas subdistrict poses the least problems concerning potential threats for its implementation as in the planned area of the land consolidation project in Sidabravas subdistrict the landed property productivity rate is high enough, the area does not contain any cultural heritage or environmental objects, there are no plans to develop the telecommunications and energy infrastructures.

The fourth project in Skuodas and Mosedis subdistricts is assessed as the most comprehensively prepared project out of all projects under investigation. Such conclusion is drawn not only due to the completeness and rather detailed assessment of individual segments discussed in the project, but also due to the fact that it covers the segments which are not taken into account in other projects. For instance, the land consolidation project in Skuodas and Mosedis subdistricts provides a detailed consideration of the composition of the natural frame – geo-ecological divide, internal stabilization habitats and axles of geosystems, migratory corridors, etc., the assessment of the project's impact on these constituents.

The analysis of the fourth land consolidation project in Zemaiciu Kalvarija subdistrict revealed that it does not cover the change in the farming productivity after the implementation of this land consolidation project. Taking into account the fact that such projects mainly aim at amalgamating land plots and thus making farming more efficient, the absence of a more detailed assessment is to be corrected. However, the land consolidation project in Zemaiciu Kalvarija subdistrict is also viewed as positive since it contains a rather detailed explication of the data, the consideration of the land consolidation impact and the features of individual segments of the project area. This project, along with the Skuodas and Mosedis land consolidation project, is considered to be exemplary and should be regarded when preparing other land consolidation projects.

The results of the analysis of the land consolidation projects in Western Lithuania can be compared with basic SWOT analysis parameters established in other land consolidation projects carried out in Lithuania (Gilvickienė, 2009). Gilvickienė (2009) has indicated the following weaknesses of the land consolidation projects:

- The land consolidation process must include the final clean-up work. If roads are only designed but not installed, the formed situation will be demolished, the expectations of landowners will not be met.
- Low activeness of landowners. Complex preparation and implementation procedures for land consolidation projects.
- Land consolidation projects must provide funding for infrastructure development, environmental protection and other measures.
- The lack of public information system about the land consolidation process.
- Land consolidation projects may be initiated by landowners, public land trustees and county governor. This limits the opportunity for other persons who are not entitled to initiate, however, are interested in the land consolidation project (local action group, Forest Management, Protected Area Management, etc.) to participate in the land consolidation processes.

These weaknesses (although in a slightly different form) are also relevant in land consolidation projects carried out in Western Lithuania. For instance, the analysis of both Upyna and Luoke land consolidation project and Saukotas land consolidation project revealed that many aspects relating to the installation and development of infrastructure were not assessed, the awareness of interested

persons about the preparation and the implementation process of the project was not systematically held.

It can be stated that projects under investigation (as the overall land consolidation process in Lithuania) lack systematicity, consideration of the infrastructure development plans and their possible impact on the land consolidation. It is the aspect which is the most important in the event of land consolidation projects as it is related not only to the interests of landowners, but also to the fact that entities under the authority of the state are required to ensure the smooth development of such infrastructure (in order to meet the consumers' needs of energy and telecommunications). In this regard, it is appropriate to involve persons related to the relevant infrastructure (the construction of roads, telecommunications and communications facilities, energy equipment) in preparation and implementation process of the land consolidation project, to assess their plans in the field. This would ensure a more successful implementation of land consolidation projects not only at the time of their development and implementation but also in the future, as such compatibility with the infrastructure development plans, on the one hand, would meet the needs of landowners (to produce the electricity, telecommunications, communication, etc.), on the other hand, would allow to avoid future disputes on the incompatibility of the project with the infrastructure development plans.

After the assessment of general weaknesses of land consolidation projects, positive aspects of such projects were also reviewed. V. Gilvickienė (2009) presents the following strengths of land consolidation projects held in Lithuania:

- The implementation of pilot projects for land consolidation lead to the development of the legal framework of land consolidation.
- The increase of productivity, efficiency and competitiveness in the agricultural sector.
- Formation of rational land use, its structural improvements.
- Creating conditions for the development of rural infrastructure.
- Goals and objectives of environmental policy are implemented during the consolidation process.
- Formation of competitive farms capable of competing with EU farms.
- Creation of new jobs as the result of the formation of competitive farms.
- Sustainable development of Lithuanian rural regions.

Taking into account these observations, it appears that the analysed Western Lithuanian projects meet the strengths of land consolidation projects indicated by V. Gilvickienė not only in the sense of achieving the aim (i. e. not only in respect of the result, which is sought while implementing land consolidation projects) but also in respect of the process itself.

In other words, the specified strengths are identified in respect of the result (i. e. what is the benefit of land consolidation projects for their implementation), while the present paper discusses the benefits and the positive aspects, which become apparent prior to the implementation of a land consolidation project (i. e. what benefit is gain already during the project preparation).

Attention should be drawn to the fact that in respect of the analyzed projects (as opposed to the general characteristics of land consolidation projects) it was not identified that the legal framework for land consolidation was developed. In this case the analysed land consolidation projects in Western Lithuania are considered as not contributing to the basis of the legal framework since all of them basically follow the same regulation (which is usually copy-pasted to the relevant parts of the project) without a more detailed assessment of legal provisions and possible reading and interpretation of such provisions. Although project developers should not be viewed as specialists interpreting relevant legal provisions, however, their professional attitude (in each case of formation of a relevant land consolidation project) and possible recommendations on legal regulation in projects could contribute to the improvement of the legal framework. It is believed that such a position is based on the fact that the legal regulation of land consolidation projects has been developed on abstract grounds (i. e. the main applicable pattern has been created, which should suit for all consolidation projects). However, many regulatory shortcomings and advantages become apparent at the time of specific land consolidation projects and in such cases it is appropriate to make recommendations on the improvement of legal regulation.

The interpretation of legal provisions presented by project authors (not necessarily applying to the implementation of a specific land consolidation project) could contribute to the adequate interpretation of legal rules governing land consolidation projects and the improvement of legal regulation. Without any analysis and assessment of this kind in the project documentation (even a brief review distinguishing main features), legislative bodies, on the one hand, may be unaware of relevant drawbacks of legal regulation, on the other hand, may not be interested in changing the existing

regulation since without drawbacks expressed in projects legislative bodies may argue that the regulation is appropriate and there is no need to change it.
In this regard it is advisable for authors of land consolidation projects while preparing relevant projects to not only automatically transfer (i. e. *copy-paste*) references to legal provisions governing land consolidation projects and specific provisions but also to provide a brief assessment of such provisions and their impact on a specific land consolidation project. As mentioned before, this could contribute to the improvement of the legal framework regulating land consolidation projects and certainly to its advanced application.
Another SWOT segment under investigation was opportunities of land consolidation projects. The most relevant opportunities of land consolidation projects in Lithuania are the following (Gilvickienė, 2009):

- The European Union provides funding and allows the development of land consolidation process in Lithuania.
- Possibility to clean up the abandoned, unused, however, fertile land.
- Possibility to diversify economic activity.
- Possibility to rearrange small, scattered land plots into rational land suitable for effective use.
- Afforestation of inefficient land plots, park planting.
- Creation of new jobs.

Most of the listed opportunities are mainly concerned with the influence of land consolidation projects on other areas directly unrelated to the intended outcome (to amalgamate land plots and thereby increase the agricultural efficiency and productivity in the project territory) of land consolidation projects (such as the creation of new jobs, improvement of landscape, preservation of natural and cultural heritage).
The analysis of land consolidation projects in Western Lithuania leads to the similar conclusion since almost all land consolidation projects under investigation include at least a brief assessment and impact of these projects on the aforementioned areas. It is mostly noticeable in solutions impact assessment, which specified how the implementation of land consolidation projects will contribute to areas directly unrelated to the amalgamation of land plots. Thus, in this respect, the analysed land consolidation projects in Western Lithuania are regarded as complying with general trends of such projects.
Threats of land consolidation projects in Lithuania are the following (Gilvickienė, 2009):

- There are no safeguards protecting consolidated land plots against the reverse process – splitting.
- Notwithstanding the ecological, cultural aspects but only seeking to increase agricultural production, the threat is imposed to the preservation of biodiversity, soil erosion, landscape changes.
- If land consolidation projects do not provided sources of funding for infrastructure development and environmental protection in advance, land consolidation solutions will not be fully implemented.
- The imperfection of legislation governing land consolidation process may have a negative impact on further development of land consolidation process in Lithuania.
- Low activeness and sceptical attitude of landowners to this process.

As previously stated, one of the drawbacks revealed during the analysis is the fact that authors of land consolidation projects basically only copy-paste legal provisions governing land consolidation projects but fail to get into a more detailed interpretation of such legislation, avoid to provide a more detailed analysis, interpretation and at least a preliminary assessment of these provisions. It can also be viewed as a threat of such projects in SWOT context since in absence of a more detailed interpretation of legislation, its proper reading and application is threatened, which may lead to disputes on the implementation of the project in the future as well as the violation of interests of relevant persons involved in the implementation process. The results of the completed analysis show that one of the threats is a passive participation of persons possibly interested in the relevant land consolidation project (i. e. the avoidance to make observations, written comments, to discuss individual elements of the project, etc.). This constitutes one of the most serious threats of such projects because if these individuals later made their comments and tried to challenge the specific land consolidation project, their rights possibly would not be defended as these persons failed to make any comments about their interests and possible infringement of their rights during the project coordination phase. Taking it into account, it is advisable for residents of related areas (or persons otherwise relating to the land

consolidation project) to always actively and promptly make comments on the project, its individual elements, the project implementation process as well as other project-related aspects. This would allow eliminating the risk of possibly unsuccessful project implementation process (to avoid the risk of challenging the project).

To sum up, the land consolidation projects held in Western Lithuania and discussed in the present paper in SWOT context are basically analogous to other land consolidation projects in Lithuania. The analysis of individual projects revealed that the developed projects lack the systemic approach and assessment, i. e. lack the analysis of individual project area-related aspects and the interface identification of the results. Only the land consolidation project in Skuodas and Mosedis subdistricts can be distinguished as presenting a rather detailed assessment of many aspects (providing not only the impact analysis on individual segments but also the overall context of such an impact).

Conclusions and recommendations

1. After the analysis of five land consolidation projects in Western Lithuania, it was determined that projects lack systemic approach and assessment, i. e. lack the analysis of individual project area-related aspects and the interface identification of the results. The projects also fail to evaluate how their implementation will affect not only the farming productivity but also the nature of the land-related infrastructure, landscape and other elements in the future.
2. The SWOT analysis of land consolidation projects held in Western Lithuania lead to the conclusion that these projects are basically analogous to other land consolidation projects in Lithuania. The main weaknesses are the following: the land consolidation process includes only the design work but not the final clean-up work of the area; low activeness of landowners; limited opportunities of some interested persons willing to take part in the process. The following strengths have been distinguished: better conditions for the development of rural infrastructure; formation of competitive farms; creation of new jobs; development of the rational land use system; planned sustainable development. Most of the opportunities are related to the impact of land consolidation projects on other areas directly unrelated to the intended outcome of the land consolidation project. Threats arise from the fact that authors of land consolidation projects basically only copy-paste legal provisions governing land consolidation projects but fail to get into a more detailed interpretation of such legislation, avoid to provide a more detailed analysis, interpretation and at least a preliminary assessment of these provisions.
3. It is recommended in the land consolidation project documentation to indicate what will be the change in the farming efficiency after the implementation of the land consolidation project and how it will be implemented at the end of the project.
4. It is advisable for authors of land consolidation projects while preparing relevant projects not to automatically transfer references to legal provisions governing land consolidation projects and specific provisions but rather to provide a brief assessment of such provisions and their impact on a specific land consolidation project. This could contribute to the improvement of the legal framework regulating land consolidation projects and its targeted application.

References

1. Di Falco S., Penov I., Aleksiev A. et al. (2010). Agro biodiversity, farm profits and land fragmentation: Evidence from Bulgaria. *Land Use Policy*. Elsevier data base, No.27, p. 763-771.
2. Gilvickienė V. (2009). Žemės konsolidacijos Lietuvoje proceso analizė. Magistro baigiamasis darbas. Vytauto Didžiojo Universitetas. From: (http://vddb.library.lt/obj/LT-eLABa-0001:E.02~2009~D_20090810_150440-34724).
3. Gonzalez X.P., Alvarez C.J., Crecente R. (2004). Evaluation of land distributions with joint regard to plot size and shape. *Agricultural Systems*, Vol. 82, p. 31–43.
4. Lisec A., Primozic T., Perlan M. et al. (2014). Land owners‘ perception of land consolidation and their satisfaction with the results – Slovenian experience. *Land Use Policy*. Elsvier data base, Vol.38, p. 550-563.
5. Mihara M. (1996). Effect of agricultural land consolidation on erosion processes in semi-mountainous paddy fields of Japan. *Journal of Agricultural Engineering Research*, Vol. 64, p. 237–247.
6. Pašakarnis G., Malienė V. (2010). Towards sustainable rural development in Central and Eastern Europe: Applying land consolidation. *Land Use Policy*. Elsvier data base, Vol.27, p. 545-549.
7. Roose A., Kull A., Gauk M., Tali T. (2013). Land use policy shocks in the post-communist urban fringe: A case study of Estonia. *Land Use Policy*. Elsvier data base, Vol.30, p. 76-83.
8. Sklenicka P. (2006). Applying evaluation criteria for the land consolidation effect to three contrasting study areas in the Czech Republic. *Land Use Policy*. Elsvier data base, Vol.23, p. 502-510.

9. Sklenicka P., Janovska V., Salek M. et al. (2014). The Farmland Rental Paradox: Extreme land ownership as a new form of land degradation. *Land Use Policy*. Elsvier data base, No. 38.
10. Van Dijk T. (2007). Complications for traditional land consolidation in Central Europe. *Geoforum*. Science direct data base, Vol.38, p. 505-511.
11. Vitikainen A. (2004). An overview of Land Consolidation in Europe. *Nordic Journal of Surveing and Real Estate Research*. Finland, Vol.1, p. 25-44.

Information about author
Midona Dapkienė Doctor of Technological Sciences, assoc. professor of the Institute of Hydraulic Construction Engineering, Water and Land Management Faculty, Aleksandras Stulginskis University, Lithuania. *Address:* Universiteto g. 10, LT-53361 Kaunas-Akademija, Kaunas district. Tel. (+370 37) 75 23 93. E-mail: midona.dapkiene@asu.lt. Field of interest: environmental engineering.
Jolanta Valčiukienė. Lector at the Institut of Land Management and Geomatics, Aleksandras Stulginkis University. Address: Universiteto g. 10, LT-53361 Akademija, Kauno r. Tel (837) 75 23 72, e-mail: valciukienejolanta@asu.lt
Edita Selmonė. Master degree student at the Institut of Land Management and geomatics, Aleksandras Stulginkis University. Address: Universiteto g. 10, LT-53361 Akademija, Kauno r., e-mail: melinaviciuteedita@gmail.com

UTILISATION POSSIBILITIES OF ABANDONED LAND BY APPLYING MULTI-CRITERIA ANALYSIS

Jolanta Valčiukienė, Daiva Gečaitė
Aleksandras Stulginskis University

Abstract
The article analyses a significant 21st century issue of land abandonment. Land abandonment occurs due to a variety of reasons, including natural, social, economic, politic, geographic and holding structure factors. The article employs methods of scientific literature, statistical data, cartographical data, multi-criteria analysis, generalisation and logical reasoning in order to analyse the extent of land abandonment and possibilities of its utilisation in Lithuania. In order to determine rational possibilities of utilisation of abandoned land, the analysis of 36 particular abandoned land areas was carried out by taking into account 11 delineated criteria that are significant for finding alternatives for utilisation of abandoned land. It was determined that the majority of abandoned land areas, i.e., 10.58 ha, are expedient for afforestation (24 abandoned land areas), and the rest areas comprising 9.25 ha are expedient to revival of agricultural activities.
Key words: abandoned land, agricultural land, utilisation of abandoned land, multi-criteria analysis.

Introduction

Abandoned land is a significant problem of the 21st century. Abandoned land might have been a result of a particular period unfavourable to agricultural activities where arable land was ceased to be cultivated. There might be numerous reasons of land abandonment, or combination of various circumstances that determined land abandonment in certain places (Ribokas, 2011). The analysis of the approaches of various authors suggests the following division of the factors leading to land abandonment (Rico et al., 2008; Benayas et al., 2007; Ambar, 2011a; Brouwer, Baldock, 1997):

- natural –slope of the land plot, complex terrain, poor soil;
- social – rural depopulation, lack of education and financial resources, unwillingness to take over farms from people who retreat from agricultural activities;
- economic – price fluctuations, increased prices of resources and relatively low yield potential, small payments, risk due to low demand for agricultural production;
- politic – land reform, lack of Government investment;
- geographic location – poor accessibility and transportation to land parcels;
- holding structure – small and uncompetitive holdings.

In Lithuania, abandoned land areas are located by State Enterprise "State Land Fund" by applying remote mapping methods, i.e. using spectral images from a satellite. Spatial data of agricultural land areas is stored in the special data set AŽ_DRLT, which is available on Land Information System (www.geoportal.lt). This data set is updated annually with the latest digital orthophoto maps, georeferenced cadastral data and other information specified by National Land Service under the ministry of Agriculture of the Republic of Lithuania. The smallest area of spatial objects, the data of which is collected in AŽ_DRLT, is 0.10 ha (Apleistos..., 2013).

Abandoned land for agricultural purposes can be restored through environmentally or economically alternative means, for instance, by afforestation. In Latvia, it is one of the most popular utilisation alternatives of abandoned land. Also, there is an option of restoration of abandoned lands so that they could be re-used for agricultural activities. Another option is to sell abandoned land plots or lease them to people who can utilise them properly and efficiently. According to P.Aleknavičius, abandoned private land plots would be of targeted use if they were located closer to prospective land holding as it would create a great opportunity for this land to be leased by farmers or agricultural businesses (Aleknavičius, 2012). It is important to note that the increase of agricultural production volumes by exploiting potentially fertile abandoned lands and inefficiently utilised agricultural land would not only contribute to reduction of the number of abandoned land areas, but would also create conditions for the development of competitive agricultural economy.

In recent years, the number of abandoned land areas in Lithuania has increased (Fig. 1).

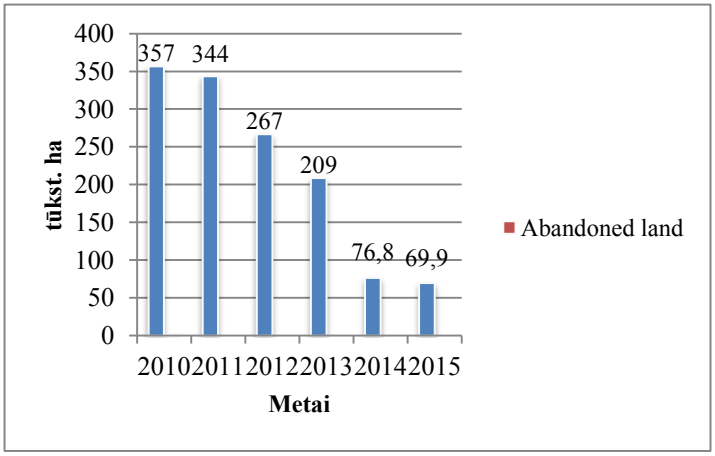


Fig. 1. Changes in the number of abandoned land in 2010 – 2015
Sources: Mano..., 2012; Valstybės..., 2013; Nacionalinė..., 2015; Nacionalinė..., 2016a

The greatest number of abandoned land areas was observed in 2010. According to the data of July of the previous year, there was 69.9 thousand of land abandoned by the owners. Decreasing number of abandoned land areas in Lithuania shows that more and more people started to take care of their owned lands and look for alternative ways to utilise it. It is likely that the number of abandoned land decreased due to a higher land tax, which may vary in different municipalities from 0.01 to 4 percent of the land value

The highest number of abandoned lands is observed in the problematic Eastern Lithuania region due to unproductive soil and lower number of working-age rural residents.

The problem of abandoned lands exists almost everywhere in Europe. For example, in Latvia, especially since 1990, the emergence of abandoned lands and natural growth of forests have become an integral part of the Latvian rural landscape. This was determined by various factors, such as structural changes, features of the landscape and environment. Both in Latvia and Lithuania it is restitution of property which highly influenced the emergence of abandoned lands. Even though people reside in cities and are not interested in agricultural activities, they still were restituted their formerly owned land in villagers. What is more, abandoned lands are determined by economic, social and political factors. In Latvia, unproductive lands are mainly utilised by means of afforestation and fertile lands are reclaimed for cultivation (Ruskule et al., 2012).

In Estonia, reduction of land abandonment plays an important role in the activities of public authorities as well as other relevant institutions. One of the biggest counties in Estonia, namely, Tartu County, is analysed into greater detail. There is 26 351 ha of abandoned land in Tartu County, 20 741 ha of it being completely abandoned (covered with scrubs or even forests) and the rest being partly abandoned (covered with woody plants). Even though abandoned areas are distributed throughout the whole region, most of them are found near water bodies and forests. In Tartu County, there are observed separate abandoned areas ranging from 2.9 to 21 ha, however, very small abandoned land areas may also be found. There are intentions to use the abandoned land for afforestation, the possibility to use abandoned land areas in bioenergy field is also discussed (Kukk et al., 2010).

The issue of abandoned land is also relevant in Mediterranean European countries (Spain, Italy and Portugal). It was noticed already in 1950 that the land was ceased to be used for traditional agricultural purposes as meadows and arable land had transformed into naturally grown forests. This occurred mainly due to the fact that the areas are hilly and it is difficult to engage into agricultural activities. In these countries afforestation is one of the most acceptable means of utilisation of abandoned land (Tomaz et al., 2013).

Figure 2 provides a cartogram of all abandoned lands in Europe illustrating that abandoned land areas are found basically everywhere in Europe.

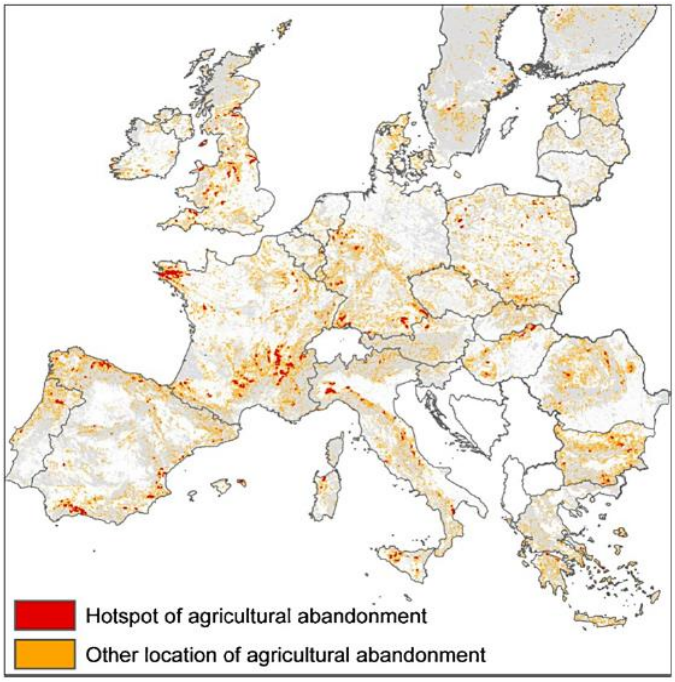


Fig. 2. Land abandonment in Europe: a) – the red colour indicates territories of great land abandonment; b) – the yellow colour indicates territories where the extent of land abandonment is not as severe (Renwick et al., 2013)

It can be observed that there is a great number of abandoned land areas in France, Great Britain, Germany, Poland and other countries. A bit lower number of abandoned lands is observed in Portugal, Denmark, and the Czech Republic. Therefore, determination of rational utilisation possibilities of abandoned land areas is a relevant issue for the entire European continent.
Hence, **the research aims** is to determine utilisation possibilities of abandoned land by applying multi-criteria analysis.

Methodology of research and materials
Raseiniai district Sujainiai cadastral area was chosen for the analysis of utilisation possibilities of abandoned land by applying multi-criteria analysis. In Raseniai district there prevails productive soil (average productivity index of agricultural land in the district is 42.2 as compared to the national average which is 39.7), hence, land abandonment should not be observed in this district. As it would be a difficult task to investigate the entire region, only one cadastral are was chosen, i.e. Sujainiai, since it is one of the rural cadastral areas in the district.
Currently, there is 841.72 ha of abandoned land in Raseiniai district, which constitutes 0.5 percent of the district area. In Sudainiai cadastral area, there are 36 abandoned land areas with a total area of 19.83 ha. The article analyses utilisation possibilities of all 36 abandoned land areas.
The research is based on the methods of scientific literature, statistical data, cartographical data, multi-criteria analysis, generalisation and logical reasoning
Key data for multi-criteria analysis was obtained from the data sets which are publicly available on the Land information System (www. geoportal. lt):

- *Mel_DR10LT* – spatial data set of reclamation status and sodden soil of the territory of the Republic of Lithuania at scale 1:10000;
- *SŽNS_DR10LT* – spatial data set of special land use conditions of the territory of the Republic of Lithuania at scale 1:10000;
- *Dirv_DR10LT* – spatial data set of soil of the territory of the Republic of Lithuania at scale 1:10000.

The aforementioned analysis is also based on the data from *maps.lt* and data set of natural frame
Utilisation possibilities of abandoned land are analysed by employing multi-criteria analysis software, namely DAM and HYPSE.
DAM (Decision Analysis Module) is a software product developed in 1999 and freely distributed by the International Atomic Energy Agency. DAM is designed for solving any tasks according to the MAUT (Multiatribute Utility Theory) method (Keeney, Raiffa, 1976). Linear and additive utility functions (U) are applied:

$$U=W_1X_1+W_2X_2+\ldots+W_nX_n \qquad (1)$$

here X_1, X_2,...X_n – criteria values (indicating which target value, higher or lower, is the best);
W_1, W_2,... W_n – significance levels of criteria (weights).

Pareto dominated (similar) alternatives are selected in the compromise solutions space and then compared with the main criterion according to the dominance test. DAM enables analysis with undefined criteria by providing criteria in min-max range.
HYPSE software (Acronym of Hydro Power Systems Evaluations) is a package designed to perform a multi-criteria analysis even by entering their weights (European..., 2000). In order to carry out the analysis, ELECTRE method (Elimination Et Choix Traduisant la Realite – Elimination and Choice Expressing the Reality), which was developed in France in 1960s, is used. (Roy,1968, 1996; Mayster et al., 1994). The advantage of this software is the possibility to use criteria of various dimensions, which is not possible in DAM. What is more, criteria may be given significance – individual effect significance level; criteria may also be grouped by indicating effect significance level of the whole group.
It is important to note that even though these two pieces of software reveal various cases of possible solutions, take risk factors into consideration, give a possibility to model their effects, describe the level of uncertainty of the solution, they, however, do not change the solution per se.
Data collection is one of the most important steps of multi-criteria analysis. The data collected are usually given in different units of measure, thus it is necessary to normalise (standardise) them so that they could be entered into the programmes. For this purpose data normalisation (standardisation) is performed. Possible types of standardisation are as follows: vector; linear scale, Min – Max procedure (Corner, Kirkwood, 1991). In this particular case Min – Max procedure is used, where values from 0 to 1 are normalised according the following formula:

$$r_{ij} = \frac{d_{ij} - \min d_{ij}}{\max d_{ij} - \min d_{ij}} \qquad (2)$$

Here r_{ij} – normalised value; d_{ij} – matrix number; $mind_{ij}$ – the smallest number in matrix; $maxd_{ij}$ – the highest number in matrix.

As opposed to DAM, HYPSE does not require normalisation of data.
The main aim of using these two pieces of software is to determine which of the 36 abandoned lands are expedient to restoration of agricultural activities and which ones are most suitable to afforestation. At is has already been mentioned, these options are considered to be the basic and most popular ones for rational utilisation of abandoned land areas. In order to solve the task, it is important to define criteria that will constitute the basis for decision-making. What is more, the accuracy of multi-criteria analysis depends on detailed selection of criteria. When selecting criteria it is important to evaluate and consider a variety of quantitative and qualitative factors that have impact on ration utilisation of abandoned land areas. This research defines 11 criteria (Table 1).

Table 1

Criteria used in multi-criteria analysis and the basis for criterion selection

No.	Criterion	The basis for criterion selection
1	2	3
1.	Productivity index	This criterion is very important for determining utilisation possibilities of abandoned land as it shows quality and value of the soil. According to the Regulations of Afforestation in Non-forest Land (2004), afforestation can be initiated in agricultural land with the productivity index not higher than 32. If the index is higher than 32, it is expedient to use abandoned land areas for agricultural purposes. This study determines productivity index determined according to soil productivity evaluation plans by calculating the average agricultural land productivity index.
2.	Distance from the settlement centre (km)	The distance of land plots from the settlement centre is of high importance to the farmers. If the land is quite far from the settlement, cultivation of such land is significantly more expensive. This study is based on the presumption that the further abandoned land is located from the settlement centre, the more suitable it is to afforestation.

1	2	3
3.	Configuration (regular – 1, irregular – 0)	Configuration of the abandoned land area is also important for the analysis of land utilisation possibilities. Farmers find it easier to cultivate regular-shaped (rectangular) land plots. This study is based on the presumption that the more irregular-shaped abandoned land area is, the more suitable it is to agricultural activities.
4.	Size of land plots (ha)	Land plots greater in size are more convenient and profitable to cultivate. Size of the land plot is a significant indicator in determining utilisation possibilities of abandoned land as the bigger land plot is, the more suitable it is to agricultural activities.
5.	Access by vehicles (yes – 1, no – 0)	All land plots should be accessible by vehicles. Thus, if the abandoned land area or the land plot where it is located cannot be accessed by car, this abandoned land should be used for afforestation.
6.	Reclamation status (not drained – 0, drained to a large extent – 1, drained – 2)	The soil of sodden, undrained land plots is difficult to cultivate. This study is based on the presumption that abandoned land located in undrained area is more suitable to afforestation.
7.	Special conditions of land and forest use (not applicable – 0, applicable – 1)	Special conditions of land and forest use impose certain limitations on farmers in terms of land cultivation. Hence, the study is based on the presumption if abandoned land area or land plot where it is located are applied special conditions of land or forest use, this land should be used for afforestation.
8.	Interposed between forests /adjacent to the forest (interposed/adjacent – 1, not interposed/not adjacent – 0)	According to the Regulations of Afforestation in Non-Forest Land (2004), it is advisable to carry out afforestation in agricultural land interposed between forests. Hence, the study is based on the presumption that if the abandoned land plot is interposed between forests or is adjacent to the forest, it should be used for afforestation.
9.	Is a part of natural framework yes – 1, no – 0)	According to the Regulations of Afforestation in Non-Forest Land (2004), afforestation is allowed in protection zones of natural framework and as a part of natural framework. Hence, the study is based on the presumption that if the abandoned land are is in the territory of natural framework, it should be used for afforestation.
10.	Terrain (flat – 0, hilly – 1)	Flat-surfaced land plots are easier to cultivate. If the abandoned land area is hilly and uneven, it is much more difficult to use it for agricultural activities. Hence, the study is based on the presumption that hilly abandoned land should be used for afforestation.
11.	Prevailing granulometric composition (sand, sandy loam – 0, loam, clay – 1)	Crop productivity depends on granulometric composition of the surface. Due to the soil type, sands are not suitable to intensive agricultural activities. The study is based on the presumption that if abandoned land area is in the sands, it should be used for afforestation.

Thus after the criteria necessary for finding the task solution had been selected and grounded, and various data sets had been used, the required data was fully collected. Criteria bounds are very important in finding solutions to the task, i.e. which abandoned land areas are expedient to restoration of agricultural activities and which ones are most suitable to afforestation. Criteria bounds differ depending on potential alternatives of abandoned land utilisation (afforestation or agriculture). The data matrix with criteria bounds for selection of different possible alternatives of abandoned land utilisation are provided in Tables 2 and Table 3.

Table 2

Data matrix for determination of which abandoned land areas are suitable to agricultural activities

Bounds	Criteria	Abandoned area number			min	max
		1	...	36		
max	Productivity index	24	28	36	14	47
min	Distance from the settlement centre, km	4.9	4.6	9.3	4.4	12.5
max	Configuration (regular –1; irregular – 0)	1	0	0	0	1
max	Size of the land plot, ha	0.1	0.99	3.79	0.1	3.79
min	Is a part of natural framework (yes –1/ no – 0)	1	0	0	0	1
max	Access by vehicles (yes – 1; no – 0)	1	0	1	0	1
min	Terrain (flat – 0, hilly – 1)	0	0	0	0	1
max	Reclamation status (not drained - 0; drained to a large extent – 1; drained – 2)	0	1	1	0	2
min	Special conditions of land and forest use (not applicable – 0 , applicable – 1)	0	0	1	0	1
max	Prevailing granulometric composition (sand, sandy loam – 0, loam, clay – 1)	0	0	0	0	1
min	Interposed between forests /adjacent to the forest (interposed/adjacent – 1, not interposed/not adjacent – 0)	1	1	1	0	1

Table 3

Data matrix for determination of which abandoned land areas are suitable to afforestation

Bounds	Criteria	Abandoned area number			min	max
		1	...	36		
min	Productivity index	24	28	36	14	47
max	Distance from the settlement centre, km	4.9	4.6	9.3	4.4	12.5
min	Configuration (regular -1; irregular - 0)	1	0	0	0	1
min	Size of the land plot, ha	0.1	0.99	3.79	0.1	3.79
max	Is a part of natural framework (yes -1/ no - 0	1	0	0	0	1
min	Access by vehicles (yes - 1; no - 0)	1	0	1	0	1
max	Terrain (flat - 0, hilly - 1)	0	0	0	0	1
min	Reclamation status (not drained - 0; drained to a large extent - 1; drained -2	0	1	1	0	2
max	Special conditions of land and forest use (not applicable - 0 , applicable - 1)	0	0	1	0	1
min	Prevailing granulometric composition (sand, sandy loam - 0, loam, clay - 1)	0	0	0	0	1
max	Interposed between forests /adjacent to the forest (interposed/adjacent – 1, not interposed/not adjacent – 0)	1	1	1	0	1

Hence, based on the created matrices and the aforementioned software, a multi-criteria analysis of abandoned land utilisation possibilities was performed. The obtained analysis results were summarised and corresponding conclusions and calls for discussion were presented.

Discussions and results

Proper utilisation of abandoned land is an important factor for its analysis. In the majority of countries, utilisation alternatives include afforestation of this land or its use for agricultural activities by restoring land areas degraded with tree stands and scrubs. Afforestation of abandoned land has a positive impact on the climate change mitigation and development of forest area and ecological stability.

Currently, there is 69994.60 ha of abandoned land in Lithuania, which makes up 1.1 percent of the total area of the country. If all abandoned land areas were afforested, the forest coverage in Lithuania would increase to 2268466.98 ha, which makes up 37.7 percent. According to General Plan of Lithuania, if abandoned lands in Lithuania were afforested, the forest coverage in Lithuania could even increase to 37 – 38 percent. (Lietuvos…, 2002). Hence, the state has to promote afforestation of abandoned agricultural land in order to implement the provisions of General Plan of Lithuania (Miškų..., 2015; Nacionalinė..., 2016a). Restoration of agricultural activities in the abandoned land area is also important, especially if it estimated to have a high agricultural land productivity index. It paves the way not only for development of agriculture, but also for economic development.

Research results with DAM software. According to Pareto dominance test results, abandoned land area No. 28 is the most suitable to agricultural purposes, and land area No. 6 (Fig. 3) is not suitable at all for agricultural activities.

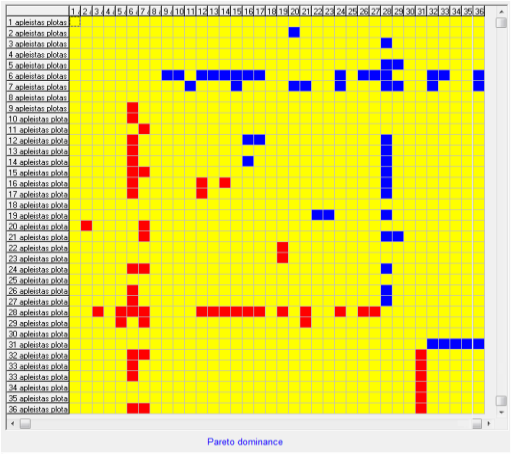


Fig. 3. Pareto dominance test for the analysis of abandoned land areas suitable to agricultural activities

The rest abandoned land areas are distributed quite diversely. Abandoned lands areas No. 16, 17, 29 may be distinguished as being suitable to agricultural activities, however, and other land areas show one or several advantages, but a more detailed analysis is required in order to determine whether they are suitable to agricultural activities. The rest land areas are suitable to both afforestation and agricultural activities.

Further, an alternative dominance test is performed with only one main criterion being distinguished. In this case, productivity index is the main criterion. It is one of the basic criteria when performing analysis on abandoned land suitability to agricultural activities (Fig. 4).

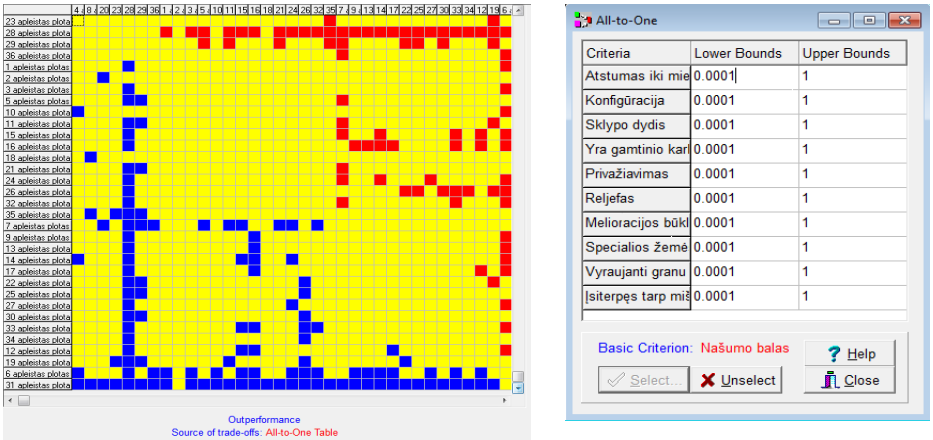


Fig. 4. Alternative dominance test with the main criterion selected (productivity index) for agricultural utilisation

It was determined that abandoned land area No. 28 remains the most suitable to agricultural utilisation in terms of productivity, however, in this case abandoned land area No. 31 is regarded as least suitable to agricultural activities, and land area No. 6 is also still regarded as less suitable to agricultural purposes. The rest land areas are distributed quite diversely.

Alternative dominance test was also performed with another criterion, i.e. granulometric composition which is prevailing in the abandoned land area. This criterion is important in terms of agricultural activities as crop yield depends on this criterion. According to the obtained results, abandoned land area No. 28 is still the most suitable to agricultural activities. Abandoned land areas No. 6 and No. 31 are still considered to be least suitable to agricultural activities.

In order to increase the accuracy of the analysis, the "What-if" analysis was performed by changing values of the following criteria: the land area is interposed between forests, it is a part of natural framework, there are special conditions of land and forest use. The results obtained remain the same, i.e., abandoned land area No. 28 is the best alternative for agricultural utilisation, land area No. 29 is also one of the best alternatives, and the worst alternative, as previously shown by Pareto and alternative dominance test, is abandoned land are No. 31 (Figure 5).

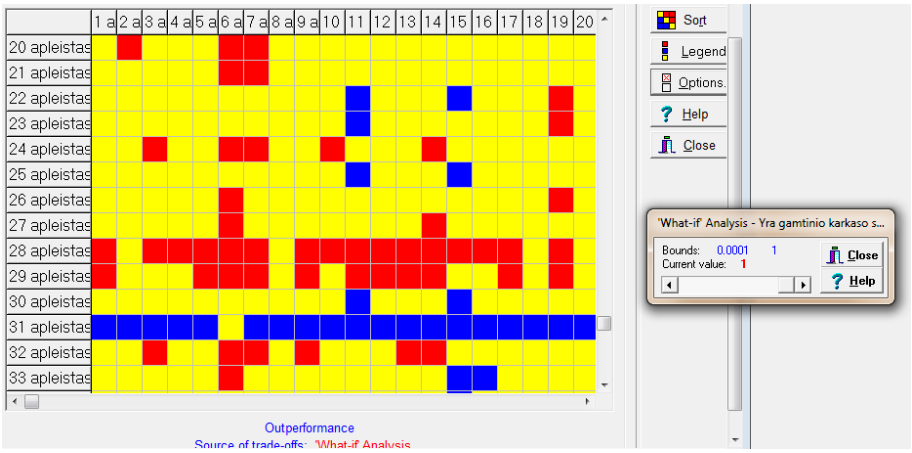


Fig. 5. "What-if" analysis with the criteria – abandoned land area is a part of natural framework

In order to determine abandoned land plots which are completely suitable to agricultural utilisation, the alternative dominance test was performed with all criteria. The results obtained are provided in Table 3.

Table 3

Optimal alternatives by all criteria

Criteria	Abandoned land areas optimal to agricultural activities
Productivity index	1;4;8;9;10;11;18;20;22;23;25;28;29;32;34;35;36
Distance from the settlement centre, km	1;4;8;10;11;18;20;22;23;25;28;29;32;34;35;36
Configuration	1;4;8;10;11;28;29
Size of the land plot, ha	4;8;10;18;20;23;28;29;32;35;36
Is a part of natural	8;11;20;28;29;32;36
Access by vehicles	1;8;11;22;23;25;28;29;34;35;36
Terrain	1;4;8;10;28;29;32;34;36
Reclamation status	8;20;28;29;36
Special conditions of land and forest use	1;8;22;25;28;29;32;34
Prevailing granulometric composition	2;4;8;10;18;20
Is Interposed between forests /adjacent to the forest	11;20;22;23;28;29;34

Optimality analysis with all criteria showed that abandoned land areas No. 28 and No. 29 are best suitable to agricultural utilisation by almost all criteria.

To sum up the results obtained, it might be claimed that abandoned land areas No. 31 and No. 6 are not suitable to agricultural utilisation as they are not optimal. Abandoned land areas No. 28 and No. 29 are most suitable to agricultural activities. Other abandoned land areas might also be potentially expedient to agricultural utilisation, but more detailed analysis is required to determine their suitability.

The analysis for determining utilisation possibilities of abandoned land for afforestation was carried out analogously as the analysis for determination of utilisation possibilities of abandoned land for agricultural purposes, i.e. Pareto dominance test and alternative dominance test were performed by setting out one main criterion and "What-if" analysis was carried out. It was determined that abandoned land area No. 6 is most suitable to afforestation as it is optimal in terms of its data. Abandoned land area No. 28 is unequivocally not suitable to afforestation, areas No. 29, No. 15 and No. 17 are not suitable either. The rest abandoned land areas are distributed quite diversely. Abandoned land areas No. 7 and No. 19 might be expedient to afforestation, other abandoned land areas have one or more advantages, however, their suitability for rational utilisation requires a more detailed analysis.

To conclude, multi-criteria analysis with DAM showed that abandoned land area that is most suitable to agricultural activities is area No.28, while areas No. 16, No. 17 and No. 29 being suitable to a lesser extent. Land area No. 6 is most suitable to afforestation, areas No. 7 and No. 19 being suitable to a lesser extent. Utilisation possibilities of the rest land areas are not clear as they have one or several advantages, but it is not enough to determine rational possibilities of their utilisation and more thorough analysis is necessary. HYPSE software is used for more accurate analysis as it does not only give a possibility to determine the best or worst alternative, the most suitable or less suitable activity with regard to a particular land area, but it also enables determination of rational utilisation of the land areas according to the results obtained.

Research results with HYPSE software. The analysis with HYPSE software was performed with the same criteria, whose weight is the same as it was in DAM, i.e., the weight of all criteria in terms of the result is 9.09 each. It was determined that abandoned land area No. 28 is most suitable to agricultural activities and area No 6. was determined to be least suitable to agricultural activities (the same as with DAM software) (Fig. 6).

Fig. 6. Results of the analysis of abandoned land areas suitable to agricultural activities

The analysis showed that abandoned land area No. 6 is most suitable to afforestation (the same result as with DAM) and that abandoned land area No. 28 is least suitable to afforestation (Fig. 6).

Fig. 6. Results of the analysis of abandoned land areas suitable to afforestation

The comparison of both utilisation alternatives of abandoned land areas by different pieces of software revealed that the majority of abandoned land areas (24) are suitable to afforestation and 12 abandoned land areas, which make up 9.25 ha, are suitable to restoration of agricultural activities (Table 2).

Table 2

Indicated rational utilisation possibilities of abandoned land areas

Analysed activities of abandoned land areas	Numbers of land areas suitable to a particular activity	Total (ha/number of abandoned land areas)
Forestry activities	1; 2; 3; 4; 5; 6; 7; 8; 9; 10; 12; 13; 14; 18; 19; 21; 22; 25; 27; 30; 31; 33; 34; 35	10.58/24
Agricultural activities		9.25/12

The greatest number of abandoned land areas which are suitable to afforestation are located near the already formed forests, and land areas suitable to agricultural activities are closer to cultivated fields, they are not interposed between forests or adjacent to them, can be accessed by vehicles and are not far away from settlements.

Conclusions and proposals

1. The issue of abandoned land is relevant in all Europe. In most cases, the land is abandoned due to natural, social, economic and politic reasons, bad geographic position or holding structure.
2. In the majority of countries, utilisation alternatives include afforestation of this land or its use for agricultural activities by restoring land areas degraded with tree stands and scrubs.
3. Multi-criteria analysis of 36 abandoned land areas by 11 defined criteria showed that the majority (24) of abandoned land areas, which make up 10.58 ha, are suitable to afforestation, and the rest (12 land areas – 9.25 ha) are more suitable to restoration of agriculture.
4. Multi-criteria analysis is an objective tool which enables complex evaluation of the alternatives (in this case – utilisation possibilities of abandoned lands) and provides the best solutions in terms of the defined criteria. Therefore, the methodology provided for determination of best utilisation possibilities of abandoned land by 11 criteria can be efficiently used for the analysis of utilisation possibilities of abandoned land in other areas.

References

1. Aleknavičius P. (2012). *Teritorijų administravimas ir teisė.* Kaunas-Akademija, p. 120 - 121.
2. Ambar M. (2011). *Land abandonment Questionnaires*. International Workshop on Land Consolidation and Land Banking - Budapest, 6 - 9 June.
3. Apleistų žemės ūkio naudmenų plotų nustatymo tvarkos aprašas Iš: *Valstybės žinios*, 2013, Nr. 3D-212. [interaktyvus]. [žiūrėta 2015 balandžio 7 d.]. Prieiga per internetą: http://www3.lrs.lt/pls/inter3/dokpaieska.showdoc_l?p_id=463630
4. Benayas J. M. R., Martins A., Nicolau J. M., Schulz J. J. (2007). *Abandonment of agricultural land: an overview of drivers and consequences*. Review, Departmento de Ecologia, Edificio de Ciencias, Universidad de Alcala, 28871 Alcala de Henares, Spain, ISSN 1749-8848.
5. Brouwer F., Baldock D. *Marginalisation of agricultural land in Europe* [interaktyvus]. 1997 [žiūrėta 2015 balandžio 7 d.]. Prieiga per internetą: http://www.macaulay.ac.uk/livestocksystems/nafplio/proceedings/brouwer.htm
6. Corner J.L., C.W. Kirkwood (1991). Decision Analysis Applications in the Operations Research Literature 1970-1989. Oper. Res., 39, 206-219 p.
7. European Commision. *Small hydroelectric plants. Guide to the Environmental Approach and Impact Assessment* [interaktyvus]. 2000 [žiūrėta 2015 gruodžio 19 d.]. Prieiga per internetą: <http://moodle.asu.lt/moodle/pluginfile.php/44066/mod_resource/content/1/Guide_FROSIO_be%20Hidro.pdf.
8. European Union. *Statistical and economic information*: *report* [interaktyvus]. 2010 [žiūrėta 2015 balandžio 7 d.]. Prieiga per internetą: <http://ec.europa.eu/agriculture/agrista/rurdev2010/RD_Report_2010.pdf>.
9. Kukk, L., Astover, A., Muiste, P., Noormets, M., Roostalu, H., Sepp, K., Suuster, E. (2010) *Assessment of abandoned agricultural land resource for bio-energy production in Estonia.* Acta Agriculturae Scandinavica Section B, Soil and Plant Science, Nr. 60. ISSN 0906-4710, p. 166-173.
10. Lietuvos Respublikos bendrasis planas. Prieiga per internetą: http://www3.lrs.lt/pls/inter2/dokpaieska.showdoc_l?p_id=284951.
11. Mano ūkis portalo informacija. *Savivaldybės maksimaliai apmokestina apleistas žemes* [interaktyvus]. *2012* [žiūrėta 2015 balandžio 14 d.]. Prieiga per internetą: http://manoukis.lt/naujienos/gyvenimas-toks/16149-savivaldybes-maksimaliai-apmokestina-apleistas-zemes.
12. Maystre L.Y.; Pictet J.; Simos J. (1994). Methodes multicritcres ELECTRE. Description, conseils pratiques et cas d'application a la gestion environnmentale. Press Polytechniques et Universitaires Romandes.
13. *Miškų nuosavybė ir administracinis pasiskirstymas* [interaktyvus]. 2015 [žiūrėta 2015 gruodžio 19 d.]. Prieiga per internetą: http://www.amvmt.lt/images/veikla/stat/miskustatistika/2014/02%20Misku%20ukio%20statistika%202014_m.pdf
14. Nacionalinė žemės tarnyba žemės ūkio ministerijos valstybės įmonė Valstybės žemės fondas. *Lietuvos Respublikos žemės fondas 2016 m. Sausio 1 d.* [interaktyvus]. 2016a [žiūrėta 2016 vasario 29 d.]. Prieiga per internetą: http://www.nzt.lt/go.php/lit/Lietuvos-Respublikos-zemes-fondas.
15. Raifa H.; Keeny R.L. (1976). *Decisions with multiple objectives: preferences and value tradeoffs*. New York: Wiley.
16. Renwick A., Jansson T., Verburg P. H., Revoredo-Giha C., Britz W., Gocht A., Mccracken D. (2013). *Policy reform and agricultural land abandonment in the EU.* Land Use Policy, p. 446-457.
17. Ribokas G. (2011). *Apleistų žemių (dirvonų) problema retai apgyventose teritorijose*. Iš: *Kaimo raidos kryptys žinių visuomenėje*: mokslo darbai. Nr. 2 . ISSN 2029-8846, p. 298-307.
18. Rico E. C., Maseda R. C. (2008). *Land abandonment: concept and consequences*. University of Santiago de Compostela, ISSN 1132-2799.
19. Ruskule A., Nikodemus O., Kasparinska Z., Kasparinskis R., Brūmelis G. (2012). *Patterns of afforestation on abandoned agriculture land in Latvia.* From: *Agroforestry Systems*, Nr. 85. p. 215-231.
20. Roy B. (1968). Classement et choix en presence de points de vue multiples (la methode ELECTRE). Revue Informatique et Recherche Operationelle, p. 57-75.
21. Roy B. (1996). *Multicriteria methoology for decision aiding*. Dordrecht:Kluwer Academic pub.
22. Tomaz C., Alegria, C., Monteiro, M. J., Teixeira, C .M. (2013) *Land cover change and afforestation of marginal and abandoned agricultural land: A 10 year analysis in a Mediterranean region.* Forest Ecology and Management,. p. 40-49.
23. Valstybės įmonė valstybės žemės fondas. *2013 metų šešių mėnesių veiklos ataskaita* [interaktyvus]. 2013 [žiūrėta 2015 balandžio 14 d.]. Prieiga per internetą: <http://www.vzf.lt/download.php/fileid/382>

Information about authors
Jolanta Valčiukienė. PhD in technology science, lector at the Institute of Land Management and Geomatics, Aleksandras Stulginkis University. Address: Universiteto g. 10, LT-53361 Akademija, Kauno r. Tel (837) 75 23 72, e-mail: valciukienejolanta@gmail.com. Fields of interest: spatial planning, land administration.
Daiva Gečaitė. Master degree student at the Institute of Land Management and Geomatics, Aleksandras Stulginkis University. Address: Universiteto g. 10, LT-53361 Akademija, Kauno r. Tel (837) 75 23 72, e-mail: g.daiva33@gmail.com