THE STUDY ON THE OVERLAP OF PARCEL BOUNDARIES

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Abstract
Cadastral measurement provides cadastral data of a parcel determining its boundaries. In theory, based on the legislative regulations, the boundaries of adjacent parcels should not cross the boundaries of parcels, therefore an overlap of parcels is not possible. Yet the question arises if this requirement is met. The study has been conducted to examine the assumption regarding the possible overlap of adjacent parcels when the parcels abut a road. The study object consists of 24 parcels randomly selected from Kėdainiai district municipality, Lithuania which abut the following roads of national significance: road No. 144 (Jonava – Kėdainiai – Šeduva) and road No. 195 (Kėdainiai – Krekenava – Panevėžys) as well as regional road No. 2007 (Akademija – Šlapberžė – Beržėlė). The cadastral measurements of the selected roads were carried out in the period of 2013–2014. During the study, the analysis of the conditions of overlapping of boundaries and the areas of the overlap have been carried out. The results of the study indicate that the boundary accuracy of parcels is inaccurate in relation to road boundaries.
Key words: land plot, land plot boundaries, road.

Introduction

In accordance with the legal framework, having received the results of cadastral measurement from a surveyor and when recording the received cadastral data of real property into the Real Property Cadastre, a cadastral manager marks the above-mentioned property on the map of the real property cadastre in accordance with the provisions laid out by the Regulations of Cadastre. Prior to marking the real property boundaries on the map of the real property cadastre, it is checked, among other things, whether the real property boundaries indicated in the map of the real property cadastre do not cross the borders of adjacent parcels that have already been marked in the map of the real property cadastre and the roads that the parcel abuts (Lietuvos..., 2002). Furthermore, all the parcels have been formulated in compliance with the legal requirements laid out by the Rules of the Preparation and Implementation of Parcel Formation and Reorganisation. Based on the main principles of parcel formation and reorganisation, when forming a parcel near the roads of national significance and local roads with lanes, the boundaries of the parcel are formed counting from the boundary of the lane. If the parcel is formed near other roads, the boundaries of the parcel are determined as over 1 m from the road-bed, or trench, 2–3 m from road green plantations, or 1 m from the edge of the roadside ditch (Lietuvos..., 2004).

However, when determining the cadastral data, mistakes and various inaccuracies may often occur. Frequently, the cases to be coordinated do not comply with the requirements set for cadastral measurements. One of the main reasons of such problem is the fact that the plans of parcels have not been drawn and formulated following the applicable rules of standard documents (Balevičius et al., 2012). Even having corrected all the inaccuracies, when the cases of cadastral measurements comply with the requirements set by legal acts, inaccuracies and overlaps of adjacent parcel boundaries do occur on the map of the real property cadastre (Jonauskienė et al., 2011). The quality of the real property cadastral data depends on the quality of the initial data, landmark retained by the owner of the parcel as well as the competences of the surveyor that carries out the cadastral measurements, cadastral manager GIS engineer, specialists of the territorial branches of National Land Service Under the Ministry of Agriculture of the Republic of Lithuania. Therefore, all the above-mentioned conditions influence the accuracy of measurements (Živatkauskas, 2012).

Inaccuracies between preliminary and cadastral measurements are also frequent (Sinkevičiūtė et al., 2012a). The most frequent mistakes include the failure to coordinate parcel boundaries with the owners or users of adjacent parcels, partially filled-in act of marking-showing, failure to coordinate the plans of neighbouring parcels, failure of drawn plans of parcels to fully comply with the requirements, etc. and absent-mindedness of a surveyor (Sinkevičiūtė et al., 2012b).

As it can be observed, mistakes and discrepancies are quite frequent in the field of cadastral data (Vaitkevičienė, Kumetaitienė, 2010; Zakarevičius, Jonauskienė, 2007), therefore the question arises whether the parcel boundaries not only cross the boundaries of adjacent parcels, but also coincide with the boundaries of other parcels.

24 parcels randomly selected from Kėdainiai district municipality, Lithuania, which abut the road parcels (Lietuvos..., 1995) have been selected for the study. The study object consists of 24 randomly selected agricultural and other parcels which abut a regional road (Nr. 195, Nr. 144) and local roads (Nr. 2007). The study aims at determining the size of the parcel overlap and providing conclusions for the occurrence of such overlaps.

The aim of the study is to examine the overlaps of the boundaries of land and road parcels registered in the Real Property Register and to determine the compliance of the inaccuracies of parcel boundaries with the legal requirements.

Objectives of the study:

1.To carry out the analysis of the inaccuracies of parcel boundaries.

2. To carry out the analysis of the areas of overlap and to determine whether the area of overlap does not exceed the maximum amount of errors allowed by the legal acts.

Methodology of research and materials

The article provides the analysis of the inaccuracies between a few of the land parcel boundaries. 24 parcels were randomly selected from Kėdainiai district municipality, Lithuania, which abut the following roads of national significance: road No. 144 (Jonava – Kėdainiai – Šeduva) and road No. 195 (Kėdainiai – Krekenava – Panevėžys) as well as regional road No. 2007 (Akademija – Šlapberžė – Beržele).The cadastral measurements of the selected roads were carried out in the period of 2013–2014. All the selected parcels abut roads (Fig. 1):

- **67 %** – 16 out of 24 of randomly selected parcels abut local road No. 144 (Jonava – Kėdainiai – Šeduva);
- **25 %** – 6 out of 24 parcels (four out of which have been coordinated at the location) are near the local road No. 195 (Kėdainiai – Krekenava – Panevėžys);
- **8 %** – two out of 24 parcels are near the regional road No. 2007 (Akademija – Šlapaberžė – Beržele).
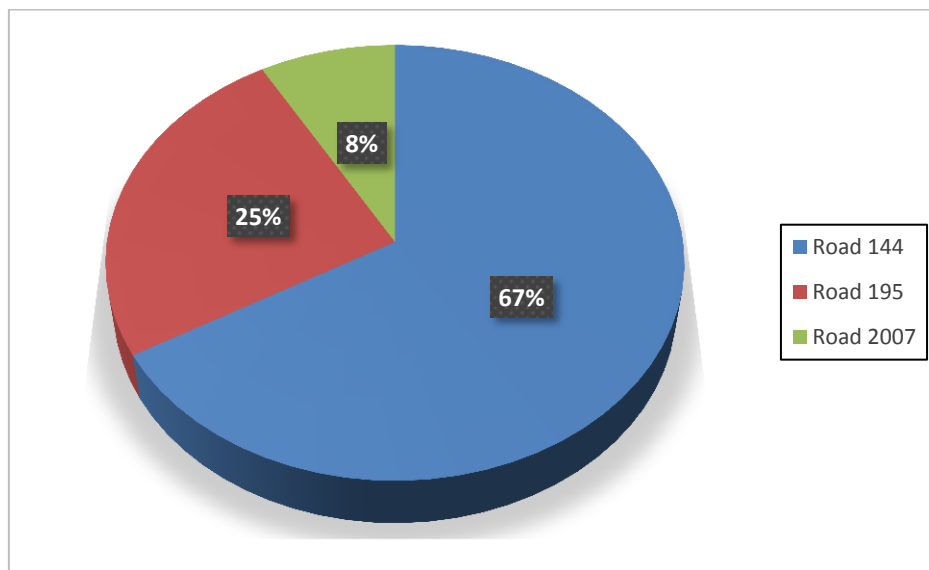
Fig. 1. The distribution of parcels which abut the roads of Kėdainiai district.

Based on the available data, the selected parcels and roads are drawn and the overlapping parcel boundaries are determined by using the programme "Geomatininkas". The overlapping areas are calculated (1, 2):

$$2P = \sum_1^n x_i(y_{i+1} - y_{i-1}),\qquad (1)$$

$$2P = \sum_1^n y_i(x_{i-1} - x_{i+1}).\qquad (2)$$

Where P – area,

x_i, y_i – the coordinates of the turning points of studied object boundaries.

In the Republic of Lithuania, when carrying out the cadastral measurements of the same boundaries by using more accurate measurement means, the area of parcel, which has been calculated by determining the cadastral data of the real property, may differ from the maximum permissible error (margin of error) applicable to the cadastral measurements of the parcel recorded in the Real Property Register by no more than maximum permissible area error (margin of error) regulated by the Regulations of Real Property Cadastre (Table 1) (Lietuvos..., 2002):

Table 1

Having carried out the cadastral measurements, the maximal permissible error between the area of parcel registered in Real Property Register and calculated area of parcel (Lietuvos..., 2002)

Used cartographic materials	Area of parcel, hectare	Scale of plan				
		1: 10000	1: 5000	1: 2000	1: 1000	1: 500
Orthophotographic maps	To 1	$0,05\sqrt{P}$	$0,03\sqrt{P}$	$0,02\sqrt{P}$	−	−
	1.1–2.0	$0,06\sqrt{P}$	$0,04\sqrt{P}$	$0,03\sqrt{P}$	−	−
	2.1–4.0	$0,07\sqrt{P}$	$0,05\sqrt{P}$	$0,04\sqrt{P}$	−	−
	4.1 and more	$0.08\sqrt{P}$	$0,06\sqrt{P}$	$0,05\sqrt{P}$	−	−
Other cartographic materials	To 1	$0.07\sqrt{P}$	$0.05\sqrt{P}$	$0.04\sqrt{P}$	$0.03\sqrt{P}$	$0.02\sqrt{P}$
	1.1–2.0	$0.08\sqrt{P}$	$0.06\sqrt{P}$	$0.05\sqrt{P}$	$0.04\sqrt{P}$	$0.03\sqrt{P}$
	2.1–4.0	$0.09\sqrt{P}$	$0.07\sqrt{P}$	$0.06\sqrt{P}$	$0.05\sqrt{P}$	$0.04\sqrt{P}$
	4.1–10.0	$0.10\sqrt{P}$	$0.08\sqrt{P}$	$0.07\sqrt{P}$	$0.06\sqrt{P}$	$0.05\sqrt{P}$
	10.0 and more	$0.12\sqrt{P}$	$0.10\sqrt{P}$	$0.08\sqrt{P}$	$0.07\sqrt{P}$	$0.06\sqrt{P}$

Since the scale applied during the study is 1/10000, the permissible error has been calculated by using the following formulas: $\mathbf{0.05\sqrt{P}}$ $\left(\text{P} - \text{Sklypo plotas iki 1 ha}\right)$, $\mathbf{0.08\sqrt{P}}$ $(\text{P} - \text{ Sklypo plotas} \geq 4\text{ ha})$, the calculated overlapping area has been compared to the maximum permissible error of the area of the registered parcel.

Discussions and results
When carrying out the study, the coordinates of all 24 parcels were uploaded onto a single drawing by using the "Geomap" software. To make the situation more clear the orthophotographic view of the selected area has also been uploaded. The results of the overlap of six parcels are represented graphically in Figure 2

a)   b)

Fig. 2. Schemes of overlapping road and land parcels (a – f)

The total areas of the selected parcels variate from 1,428.59 m^2 (14 ares) to 428,764.95 m^2 (42.9 hectares). Having analysed the overlap of all the selected parcels with road parcels, it was estimated that the overlapping areas constitute up to 338.49 m^2. The results of the analysis are provided in Table 2.

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Table 2

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Physical parameters of the analysed parcels

System of coordinates	Number of road	Total area of the land parcel (m^2)	Area of the overlap (m^2)	Shape of the parcel (regular, irregular)
LKS-94	Road 195	1837.79	2.85	Irregular
LKS-94	Road 144	1621.39	3.67	Irregular
LKS-94	Road 2007	428764.95	6.76	Irregular
LKS-94	Road 144	1450.95	6.85	Regular
LKS-94	Road 144	3260.23	11.56	Irregular
LKS-94	Road 144	3493.15	14.18	Irregular
LKS-94	Road 144	2219.63	14.38	Regular
LKS-94	Road 144	1428.59	17.25	Irregular
LKS-94	Road 144	4991.19	24.87	Regular
LKS-94	Road 195	2120.41	27.17	Regular
LKS-94	Road 144	2651.46	30.85	Irregular
LKS-94	Road 144	1498.82	31.44	Irregular

System of coordinates	Number of road	Total area of the land parcel (m^2)	Area of the overlap (m^2)	Shape of the parcel (regular, irregular)
LKS-94	Road 144	5183.06	32.81	Irregular
LKS-94	Road 195	4000.10	45.79	Irregular
LKS-94	Road 144	810.00	48.64	Irregular
LKS-94	Road 144	6089.52	49.76	Regular
LKS-94	Road 144	2500.08	50.40	Regular
LKS-94	Road 195	2199.78	56.86	Irregular
LKS-94	Road 144	1800.21	95.06	Regular
LKS-94	Road 144	6091.81	136.25	Irregular
Local	Road 195	3000.42	137.44	Irregular
LKS-94	Road 144	2937.26	148.44	Regular
LKS-94	Road 2007	9568.33	210.22	Irregular
LKS-94	Road 195	77410.41	338.49	Irregular

The distribution of the areas of overlapping boundaries of land and road parcels:
- < 10 m^2 – four;
- 10 m^2 < 20 m^2 – four;
- 30 m^2 < 40 m^2 – three;
- 40 m^2 < 50 m^2 – three;
- 50 m^2 < 60 m^2 – two;
- 61 m^2 and more – six parcel.

The smallest land parcel by the total area of the parcel constitutes approximately 8 ares. This parcel is near road No. 144, the intended purpose of the land is other. The biggest analysed parcel, whose area is approximately 43 hectares, is near road No. 2007, while the intended purpose of the land is agricultural. The estimated and calculated areas of the overlap fluctuate from 2.85 m^2 to 338.49 m^2. The total ratio of the areas of the analysed parcels is provided in Figure 3.
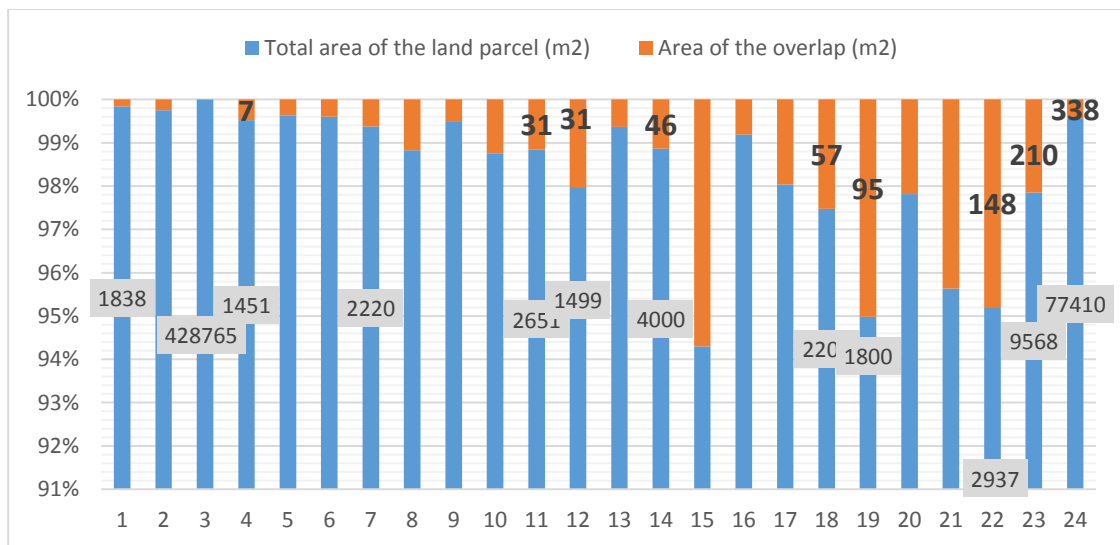

Fig. 3. The ratio of the areas of parcels

As it can be observed from Figure 3, the biggest overlaps of land and road parcels fluctuate from 48.64 m^2 to 338.49 m^2, while six of the smallest overlaps fluctuate from 2.85 m^2 to 14.18 m^2.

To check whether the discrepancies between parcel areas are within permissible limits, the maximum permissible error has been calculated for every parcel.

Since orthographic material M 1: 10 000 has been used to determine the discrepancies (based on the Regulations of Cadastre of the Republic of Lithuania, the maximum permissible error between the area of the parcel registered in the Real Property Registry and the area of parcel calculated after carrying out the cadastral measurements is provided in Table 1), the maximal permissible errors have been calculated by applying the following formulas: when the area of the parcel is (P) < 1ha – 0.05√P and when the area of the parcel is (P) > 1ha – 0.08√P. The total areas of the corrected parcels have been calculated as well (by deducting the area of the parcel discrepancy from the total area of the parcel). The results of the analysis are provided in Table 3.

Table 3

The maximum permissible errors of parcels and the areas of corrected parcels

Number of parcel	Total area of the land parcel (m²)	Area of the overlap (m²)	The maximal permissible error P<1ha - 0,05√P; P>1ha - 0,08√P, (m2)
1	1,837.79	2.85	214.35
2	1,621.39	3.67	201.33
3	42,8764.95	6.76	5238.41
4	1,450.95	6.85	190.46
5	3,260.23	11.56	285.49
6	3,493.15	14.18	295.51
7	2,219.63	14.38	235.56
8	1,428.59	17.25	188.98
9	4,991.19	24.87	353.24
10	2,120.41	27.17	230.24
11	2,651.46	30.85	257.46
12	1,498.82	31.44	193.57
13	5,183.06	32.81	359.97
14	4,000.1	45.79	316.23
15	810	48.64	142.30
16	6,089.52	49.76	390.18
17	2,500.08	50.4	250.00
18	2,199.78	56.86	234.51
19	1,800.21	95.06	212.14
20	6,091.81	136.25	390.25
21	3,000.42	137.44	273.88
22	2,937.26	148.44	270.98
23	9,568.33	210.22	489.09
24	77,410.41	338.49	2,225.82

The results of calculations show that the areas of the overlap of all the land parcels and road parcels do not exceed the maximum permissible error. The permissible errors fluctuate from 142.30 m² to 5,238.41 m². The sum of all the areas of the overlaps of all the analysed parcels amounts to 1,541.99 m² (15 are).

Having conducted the study, an assumption can be made that the overlaps of land and road parcels occurred due to the following reasons: the boundaries of the parcel were not coordinated with the owners or users of adjacent parcels, partially filled-in act of marking-showing, failure to coordinate the plans of neighbouring parcels, failure of drawn plans of parcels to fully comply with the requirements, absent-mindedness of a surveyor, various minor mistakes during the cadastral measurements, when the boundaries of parcels have been drawn, when carrying out the marking of parcels at location, etc. (Sinkevičiūtė et al., 2012b).

Conclusions and proposals

The discrepancies of parcel areas have been investigated between the local roads No. 144, 195, regional road No. 2007 and 24 parcels which abut the above-mentioned roads. The measured and calculated areas of the overlap fluctuate from 2.85 m^2 to 338.49 m^2.

The areas of the overlap of all the land parcels and road parcels do not exceed the maximum permissible error. The permissible errors fluctuate from 142.30 m^2 to 5,238.41 m^2. Due to the areas of the overlaps (discrepancies) all the parcels lose a part of the total area, which amounts to 15.4 ares and constitutes 0.3% of the area covered by all the parcels.

The discrepancies of the parcel boundaries occur due to the absent-mindedness of a surveyor, the failure of the act of marking-showing to comply with the requirements, failure to coordinate the plans of parcels, failure of the drawn plans of parcels to fully comply with the requirements.

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