

THE AGRARIAN LANDSCAPE AND THE CHANGE IN ITS SUBDIVISION OF PLOTS

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Abstract

The article presents an analysis of changes in the agrarian landscape and the subdivision of its plots, using three Lithuanian municipalities as examples (Kaunas, Trakai and Šilutė). Statistical, comparative and multicriteria analysis methods were applied in the study. It was found that in all the studied municipalities, the area of the agrarian landscape was decreasing during the study period. The largest decreasing trends were in the municipality of Šilutė district, where the area covered by agrarian landscape decreased by more than 3%. At the same time, in the municipalities of Kaunas and Trakai districts, the area of agrarian landscape decreased quite evenly and did not reach 3%. It was also found that the number of agricultural holdings also decreased: by 27% in Kaunas district municipality and by over 33% in Trakai district municipality, but the area of agricultural holdings increased in all of the studied municipalities: in Kaunas district by over 5%, in Trakai district by over 37% and in Šilutė district by over 8%. The average size of a farm in Kaunas district remained rather stable, increasing by only 1%, in Šilutė district municipality the average farm size increased by more than 71% and in Trakai district municipality the tendency was the opposite, i.e. the average farm size decreased by more than 36%. The multicriteria analysis shows that the most common factors influencing changes in the agrarian landscape and its subdivision of plots vary between municipalities, but in general the following factors influence the changes in the agrarian landscape and its subdivision of plots: the land productivity score, the number of inhabitants, the distance to the centre of the city, the average size of the farms, the number of holdings, and the amount of land area occupied by bodies of water. The information collected and the results obtained show that in the municipalities analysed, the causes of change in the agrarian landscape and its subdivision of plots have a positive impact on the sustainable development of agriculture and rural areas.

Key words: landscape, agrarian landscape, subdivision of plots, change.

Introduction

Landscape is an important spatial resource of the country, encompassing urban and rural areas, forests, water bodies and fields and creating conditions for people to live and work. Preserving the uniqueness of the landscape, managing and shaping it to meet the economic, social, cultural, environmental and aesthetic needs of society is one of the most important tasks of the Lithuanian state (Dėl Lietuvos..., 2014).

Climate and population change, as well as the use of various natural resources, have been the main factors that have changed the visual landscape. If natural processes were the only cause of landscape change, there would be very little change in the landscape, but humans are involved in the whole process of change, so the visual appearance of the landscape changes quite significantly. And the biggest influence on landscape change is the fact that people are involved in agriculture. Thus, it can be argued that landscape change is an interaction between nature and humans (Thoren, 2014; Hartvingsen, 2014). It is through people respecting nature, the inevitable changes that occur in nature, and developing a sense of responsibility for their actions affecting and changing the landscape that the negative consequences that follow changes in nature can be reduced (Heyd, 2008).

Other authors, such as Azevedo and Perera (2014), argue that landscapes are the result of the interaction between nature and humans, and that their condition is influenced by various natural factors and human activities. One of the strongest drivers of landscape change is farming, which strongly influences agrarian landscapes.

An agrarian landscape is a type of landscape shaped by natural processes and human activities. This type of landscape retains the most important features of the natural structure (Dėl Lietuvos..., 2014).

The agricultural areas that make up the agrarian landscape are characterised by the subdivision of plots of various sizes and configurations and are an integral part of the mosaic of the agrarian landscape. Plot fragmentation is linked to problems of landscape optimality and agricultural efficiency (Orlonas and Veteikis, 2016). The subdivision of agricultural land affects both agricultural production possibilities and the visual quality of the countryside (Brabec, Smith, 2002).

The subdivision of the agrarian landscape may indicate that the existing land tenure structure is problematic. This can be a serious problem in many regions as it limits sustainable agricultural development and reduces the potential for sustainable rural development. A reliable assessment of the current situation is needed to combat land subdivision, as existing indicators of subdivision may also have shortcomings. They ignore

important spatial variables, such as the shape of the plots, as well as non-spatial variables, such as the type of ownership and the presence or absence of road access for each plot of land (Demeriou et al. 2013). The agrarian landscape type covers more than half of Lithuania's territory and is characterised by different sizes and shapes of agricultural plots. With more than 93 000 people engaged in agriculture, especially in rural areas, it is very important and relevant to analyse in more detail the agrarian landscape and the changes in its subdivision of plots and to clarify the causality of these changes, to reveal whether they may, in fact, be limiting the rational development of agriculture and undermining the possibilities for sustainable rural development.

The aim of the study is to examine changes in the agrarian landscape and the subdivision of its plots in selected areas.

To achieve this, the following **objectives** are being pursued:

1. To analyze the changes in the agrarian landscape in selected areas.
2. To analyse the changes in the agrarian landscape subdivision of plots.
3. To identify the causes of change in the agrarian landscape and its subdivision of plots as well as its potential impact on the rational process of agricultural and rural development.

Methodology of research and materials

The areas (study sites) were chosen for the study based on different aspects that could be used to identify the variation and causality of the agrarian landscape and its subdivision of plots, irrespective of whether the sites are similar, i.e., the aim was to select sites with different characteristics. Thus, 3 study sites were selected:

- Kaunas district municipality is one of the most developing municipalities in central Lithuania. The municipality is undergoing a rapid process of urbanisation and population growth. Kaunas district municipality has an agricultural productivity score of 48, which is higher than the average for Lithuania (43.2), the land is fertile, and the agrarian landscape accounts for half of the municipality's total area (50.06%).
- Located in the south-eastern part of the territory of Lithuania, the municipality of Trakai district has one of the lowest productivity scores (28.70) in the whole territory of Lithuania, and the area of the agrarian landscape accounts for only 32.64% of the municipality's area. Urbanisation processes in the municipality are gradual, as the population is rather stable. The municipality focuses more on the renewal and renovation of already urbanised areas than on development.
- Šilutė district municipality is located in the western part of Lithuania and is environmentally sensitive, with protected areas occupying more than 51% of the municipality's area, while the area of the agrarian landscape also accounts for a significant (48.57%) part of the municipality's area. The productivity score for agricultural land in the district is 33.13. There is no need for urbanisation as the population of the municipality is decreasing significantly.

Thus, taking into account the above-mentioned criteria of the municipalities selected for the object of the study (different productivity scores, the extent and pace of urbanisation, and the rather different structural composition of the landscape), the study further analyses in detail the changes in the agrarian landscape and its subdivision of plots of the three municipalities of Lithuania (the districts of Kaunas, Trakai, and Šilutė).

Statistical, comparative and multicriteria analysis methods were used to analyse the changes in the agrarian landscape and its subdivision of plots, as well as the causes of change and their impact on rational agricultural and rural development in the selected districts. The following data for the period 2013-2022 were used for the analysis:

- Data from the Land Fund of the Republic of Lithuania (hereinafter referred to as "LR") (as of 1 January);
- Data from the Lithuanian Land Information System (www.zis.lt);
- Data from the Cadastre of Protected Areas of the Republic of Lithuania (as of 1 January 2022);
- Portal of the Registers of Agriculture and Rural Business and Farmers' Farms provides statistics on agricultural holdings. The choice was made to analyse the data as at 1 January of each year.

A multicriteria analysis was used to identify the main causes of change in the agrarian landscape and its subdivision of plots. This analysis was carried out using PROMETHEE software. This software can be used to identify the most significant aspects that determine the subdivision of plots of the agrarian landscape. Six criteria were set for the multicriteria analysis (Table 1).

Table 1

Criteria for multicriteria analysis to identify the causes of subdivision of plots in agrarian landscapes
(compiled by the authors)

No	Criterion	Justification of the criterion	Criterion direction
1	Agricultural land area, ha	The larger the area of agricultural land, the lower the likely subdivision of plots in agrarian landscapes.	MAX
2	Productivity score	The higher the productivity score, the more fertile the land, the more intensive the farming activity and, presumably, the larger the area of agrarian landscape.	MAX
3	Distance to city centre, km	The shorter the distance to the city centre, the higher the subdivision of plots is likely to be.	MIN
4	The area of protected areas, ha	The smaller the area of protected areas, the greater the area of agricultural land is likely to be.	MIN
5	Average farm size, ha	The larger the size of the farm, the smaller the subdivision of plots is likely to be.	MAX
6	Number of farms, units	The larger the number of farms, the higher the number of agrarian plots is likely to be.	MAX
7	Number of inhabitants, units	The larger the number of inhabitants, the more likely it is that the subdivision of plots will be higher.	MAX
8	Number of agricultural holdings, units	The larger the number of agricultural holdings, the higher the subdivision of plots.	MAX
9	Roads, km	The more roads, the more likely the higher the subdivision of plots.	MAX
10	Water bodies, ha	The larger the area of land covered by water bodies, the higher the subdivision of plots is likely to be.	MAX

The values of the criteria were assessed from the data sources listed above and collected for the study, and the criteria were weighted according to their usefulness or uselessness for achieving the objective of the multicriteria analysis. The data matrix (Table 2) was therefore developed to carry out the multicriteria analysis (Table 2).

Table 2

Data matrix for multicriteria analysis and directions of criteria for multicriteria analysis
(Compiled by the authors)

	Agricultural land area	Productivity score	Distance to the city centre	Protected areas	Average farm size	Number of farms	Number of inhabitants	Number of agricultural holdings	Roads	Water bodies
Criteria direction	MAX	MAX	MIN	MIN	MAX	MAX	MAX	MAX	MAX	MAX
Kaunas district municipality	74855.73	48.00	23.60	23782.65	5.49	2373	105032	3034	3143.76	7537.60
Trakai district municipality	39404.06	28.70	15.40	40876.66	4.53	1632	35864	1922	2209.04	5634.02
Šilutė district municipality	81718.19	33.13	12.50	82310.98	11.89	2789	42330	5138	2234.13	31958.75

The linear priority function (Linear) recommended by PROMETHEE was used for the multi-criteria analysis, as well as thresholds for identity status Q and strict priority P (Table 3). When a linear priority function is chosen, the values Q and P are included and there is a linear relationship between them. It is therefore not the fact that one indicator is higher or lower than another, but the magnitude of the change between the indicators that matter. Therefore, for favourable criteria, the programme assigns coefficient values between 0.1 and 1.0, depending on the selected Q and P values.

Table 3

Thresholds for criteria Q and P (compiled by the authors)

	Agricultural land area	Productivity score	Distance to the city centre	Protected areas	Average farm size	Number of farms	Number of inhabitants	Number of agricultural holdings	Roads	Water bodies
Q value	15352.37	6.23	3.40	17001.50	2.82	303	28158	859	423.01	11090.82
P value	43561.79	19.10	10.80	56020.39	7.72	1075	74270	3003	1046.16	28640.64

The study identified trends and causes of change in the agrarian landscape plot subdivision of municipalities and based on the findings, made assumptions about the possible consequences for sustainable agricultural and rural development.

Discussions and results

The change in the agrarian landscape between 2013 and 2022 in the municipalities analysed is presented in Figure 1.

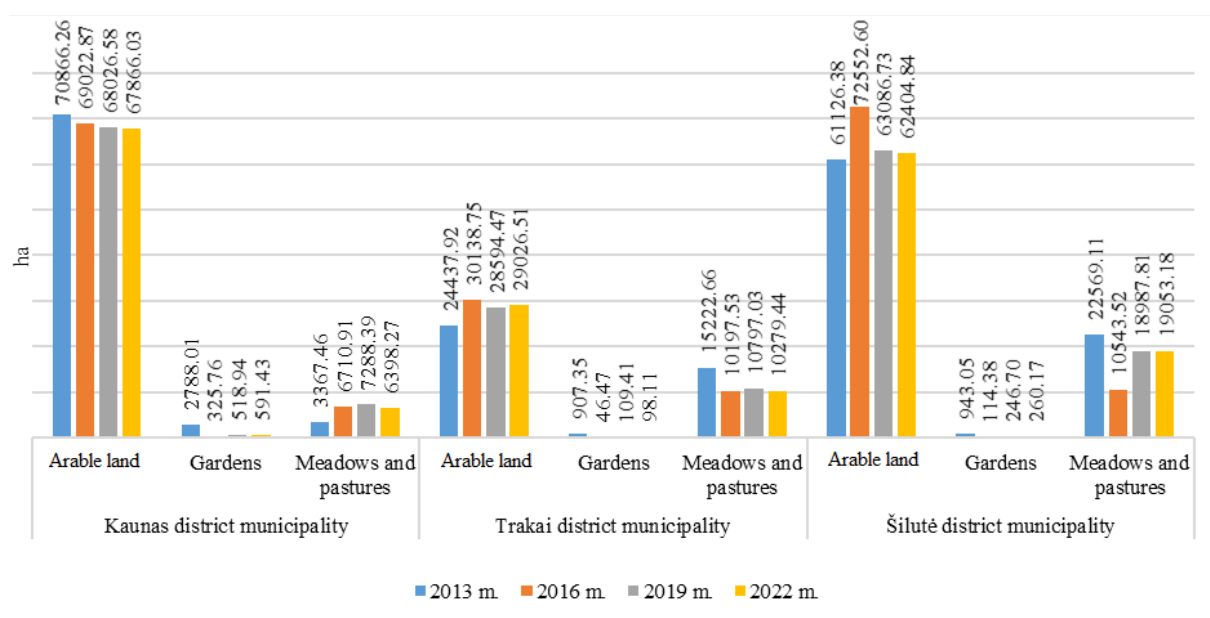


Figure 1. Change in the area of agricultural land in Kaunas, Trakai and Šilutė district municipalities in ha (Source: compiled by the authors on the basis of data from the Land Fund of the Republic of Lithuania)

It has been established that in Kaunas district municipality the agrarian landscape accounts for 50.05% of the total area of the municipality (the area of the municipality is 149548.33 ha, agricultural land – is 74855.73 ha). During the period under analysis, the area of arable land decreased by 3000.28 ha (about 4%), as did the area of gardens - 2196.58 ha (almost 79%). Meanwhile, the area of meadows and natural pastures increased by 3030.81 ha, i.e. by 90%.

In Trakai district municipality, the agrarian landscape accounted for 32.64% of the total area of the municipality (the total area of the municipality is 120732.73 ha, and agricultural land – is 39404.06 ha). During the period under analysis (2013 to 2022), the area of arable land in Trakai district municipality increased by 4588.59 ha (almost 19%). Meanwhile, the area of gardens, meadows and pastures decreased by 809.24 ha (about 89%) and 943.22 ha (about 32%) respectively.

In Šilutė district municipality, the agrarian landscape covered 48.57% of the total area of the municipality (municipal area 168245.05 ha and agricultural land area - 81718.19 ha). It was found that the area of arable land in the district increased by 1278.46 ha (about 2%), the area of gardens decreased by 682.88 ha (over 72%) and the area of meadows and pastures also decreased by 3515.93 ha, i.e. by over 15%.

The results of the analysis of the changes in the agrarian landscape are illustrated in Figures 2,3,4 and 5.

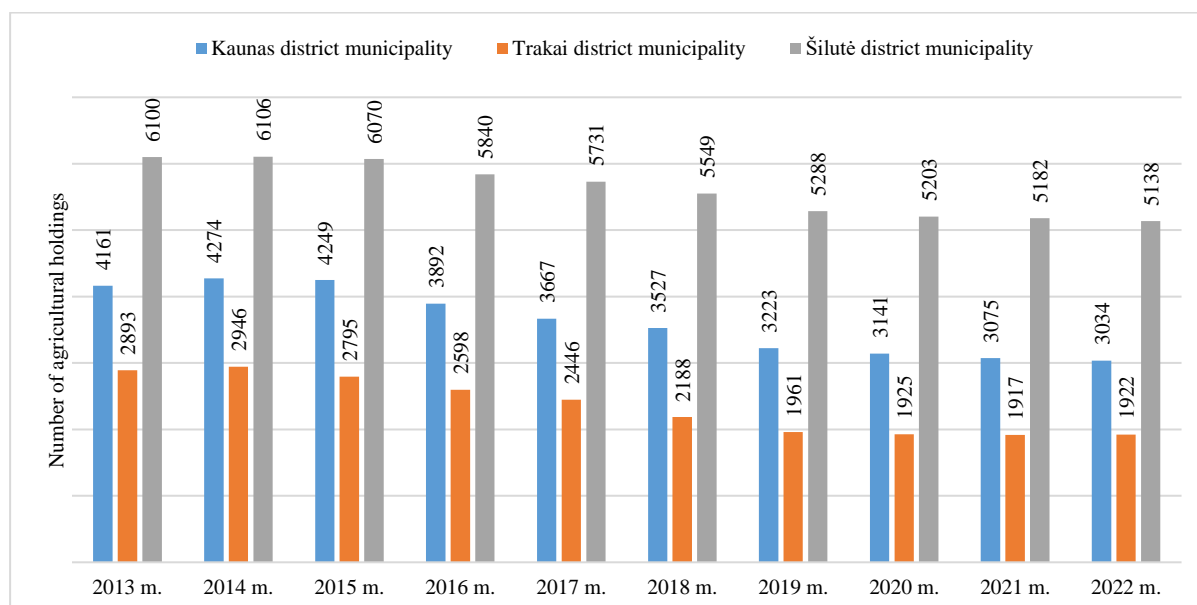


Figure 2. Change in the number of agricultural holdings in Kaunas, Trakai and Šilutė district municipalities (Source: compiled by the authors on the basis of the data of the Agricultural Holdings Portal - 1 January)

As of 1 January 2022, there were 3034 agricultural holdings in Kaunas district municipality, the average size of an agricultural holding was 93.57 ha. The distribution of the area of agricultural holdings by purpose was:

- Areas used for agricultural purposes amounted to 39982.54 ha;
- Areas used for forestry purposes - 229264.92 ha;
- Areas used for water purposes - 2311.26 ha;
- Areas used for other purposes - 10099.45 ha.

It was found that the number of agricultural holdings in Kaunas district municipality has been steadily decreasing during the period under study. From 2013 to 2022, the number of agricultural holdings in the district decreased by 1127 units, i.e. by 27.08%.

As of 1 January 2022, there were 1.922 agricultural holdings in Trakai district municipality, with an average farm size of 11.63 ha. The distribution of the area of agricultural holdings by purpose was:

- Areas used for agricultural purposes amounted to 18417.08 ha;
- Areas used for forestry purposes – 1800.85 ha;
- Areas used for water purposes – 349.58 ha;
- Areas used for other purposes – 1445.21 ha.

It was found that the number of agricultural holdings in Trakai district also decreased by 971 units, i.e. by 33.56%.

As of 1 January 2022, there were 5138 agricultural holdings in Šilutė district municipality, with an average farm size of 13.01 ha. The distribution of the area of agricultural holdings by purpose was:

- Areas used for agricultural purposes amounted to 60126.42 ha;
- Areas used for forestry purposes – 2471.62 ha;
- Areas used for water purposes – 837.47 ha;
- Areas used for other purposes – 2944.90 ha.

It was found that, as in the other two municipalities, the number of agricultural holdings in Šilutė district was also decreasing. Although from 2013 to 2015, it can be said that this indicator was steady and did not change significantly, from 2015 to 2022, there was a marked decrease in the number of agricultural holdings. During the whole period under study, the number of agricultural holdings in Šilutė district municipality decreased by 962 units, i.e. by 15.77%.

The study also analysed the evolution of the size of agricultural holdings (Figure 3).

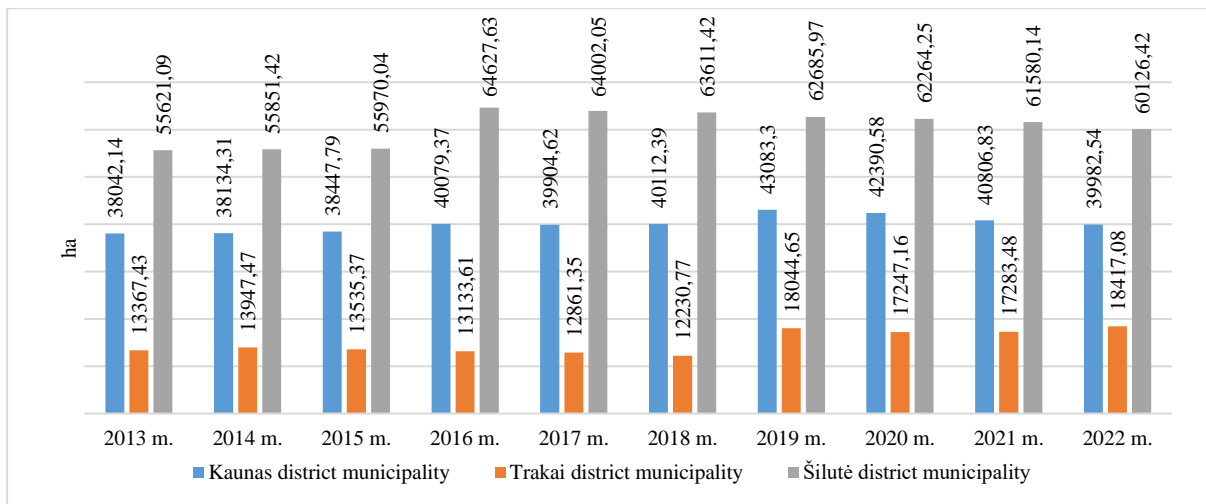


Figure 3. Area of agricultural holdings in Kaunas, Trakai and Šilutė district municipalities in ha (Source: compiled by the authors on the basis of the data of the Agricultural Holdings Portal - 1 January)

It was found that the area of agricultural holdings in Kaunas District was uneven. From 2013 to 2019, there was an increase of 5041.16 ha (more than 13%), while from 2019 to 2022, these areas decreased by 3100.76 ha, i.e. more than 7%. Summing up the whole period under study, it can be stated that the area of agricultural holdings in Kaunas district municipality increased by 1940.40 ha, i.e. by 5.10%.

Meanwhile, the area of agricultural holdings in Šilutė District remained fairly stable in 2013-2015, with a sharp increase of 8657.59 ha (more than 15%) between 2015 and 2016. Meanwhile, between 2016 and 2022, a rather steady decrease of 4501.21 ha (almost 7%) was observed. However, summarising the whole period under study, it can be stated that the size of agricultural holdings in Šilutė district increased by 4505.33 ha, i.e. by 8.10%.

The area occupied by agricultural holdings in the municipality of Trakai district has been unevenly distributed. It can be seen that from 2013 to 2018, the area decreased quite steadily by 1136.66 ha (more than 8%). Later, between 2018 and 2019, a sharp increase of 5,813.88 ha was observed, i.e. 47.53%. And between 2019 and 2022, the area can be said to have remained fairly even, with a change of only 372.43 ha, i.e. an increase of only 2.06%. Summarising the whole period under study, it can be stated that the size of agricultural holdings in the municipality of Trakai district increased by 5049.65 ha, i.e. by 37.78%, which is the highest increase among the 3 municipalities studied.

The change in the number of farms in the analysed municipalities was also studied (Figure 4).

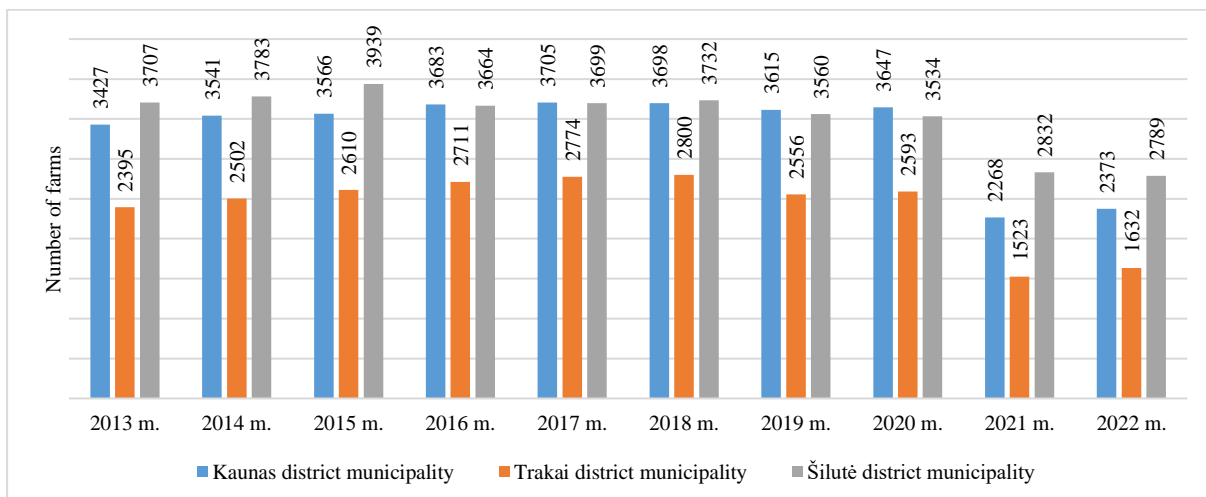


Figure 4. Change in the number of farms in Kaunas, Trakai and Šilutė district municipalities (Source: compiled by the authors on the basis of the data of the Agricultural Holdings Portal - 1 January)

The analysis of the change in the number of farms in the selected municipalities of the districts shows that the number of farms has been decreasing in all the municipalities analysed. The number of farms in Kaunas

district decreased by 1054 (30.76%) between 2013 and 2022, in Trakai district by 763 (31.86%) and in Šilutė district by 918 (24.76%).

The change in the size of the average farm is presented in Figure 5.

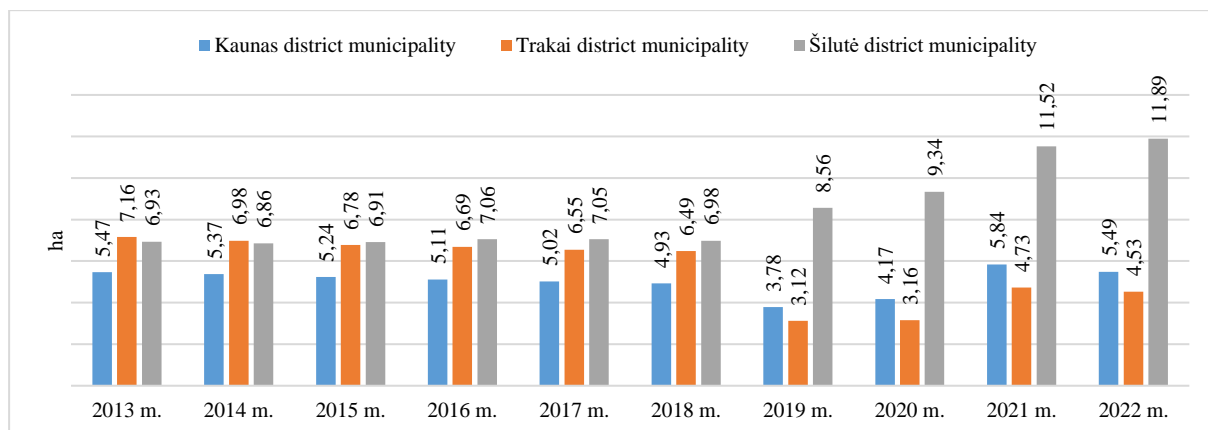


Figure 5. Change in the size of the average farm in Kaunas, Trakai and Šilutė district municipalities, ha (Source: compiled by the authors on the basis of the data of the Agricultural Holdings Portal - 1 January)

As can be seen from the figure, the average farm size in Kaunas district municipality remained fairly stable during the period under study. Between 2013 and 2022, the average farm size increased by only 0.02 ha, i.e. by only 0.36%. Meanwhile, in Trakai district municipality, the average farm size decreased by 2.63 ha (36.73%), and in Šilutė district municipality, the average farm size almost doubled, i.e. from 6.93 to 11.89 ha, i.e. an increase of 4.96 ha (71.57%).

To identify the causes of changes in the agrarian landscape and its plot subdivision, the above-mentioned multicriteria analysis was carried out, whereby the criteria were evaluated in order to determine which criterion is the strongest and which one is the weakest one of the changes in the agrarian landscape and its plot subdivision in the particular municipality under study.

The study has shown that in Kaunas district municipality the most influential factors on changes in the agrarian landscape and its plot subdivision are land productivity score, number of inhabitants and road area, and the least influential is the distance to the city centre (Figure 6).

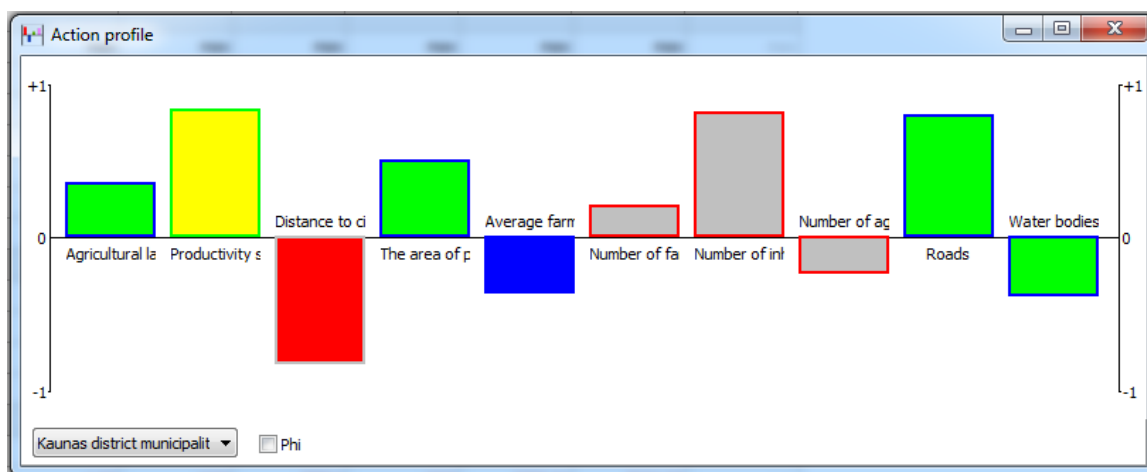


Figure 6. Analysis of Kaunas district municipality criteria by PROMETHEE Action profile test (Source: compiled by authors using PROMETHEE software)

In the municipality of Trakai district, however, there are no fundamentally exceptional indicators that influence the change of the agrarian landscape and its subdivision of plots. This change is only slightly influenced by the distance to the city centre and the area covered by protected areas, but it is clear that the area covered by agricultural land and the number of farms in the district do not have any influence at all on the change in the agrarian landscape and its subdivision of plots (Figure 7).

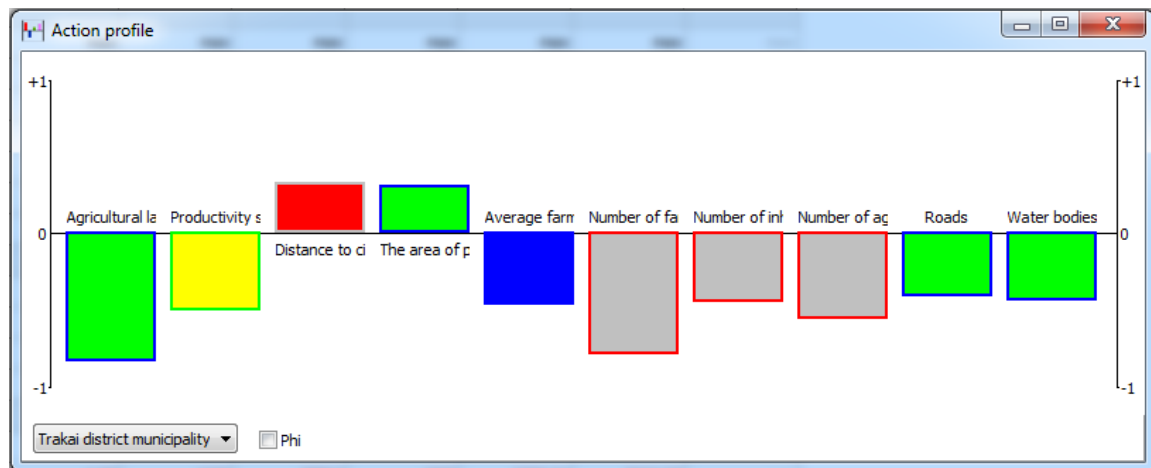


Figure 7. Analysis of Trakai district municipality criteria by PROMETHEE Action profile test (Source: compiled by authors using PROMETHEE software)

In Šilutė district municipality, almost all of the analyzed criteria have a significant influence on the change of the agrarian landscape and its subdivision of plots (Figure 8).

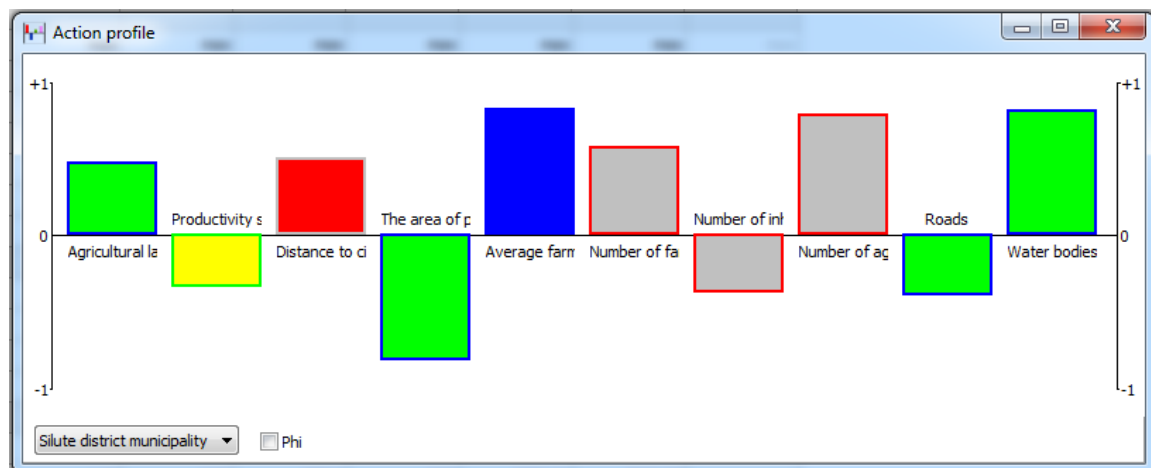


Figure 8. Analysis of Šilutė district municipality criteria by PROMETHEE Action profile test (Source: compiled by authors using PROMETHEE software)

The most significant criteria that have the greatest influence on the change of the agrarian landscape and its subdivision of plots in Šilutė district are the average size of farms, the number of agricultural holdings and the area of land occupied by water bodies. However, the size of the agricultural area, the distance to the city centre and the number of farms also contribute quite significantly to the changes in the agrarian landscape and its subdivision of plots in the district. Meanwhile, the area covered by protected areas has no influence on this change.

Summarising the information gathered and the results obtained, it can be stated that the change in the agrarian landscape and its subdivision of plots in the municipalities analysed has a positive impact on the sustainable agricultural and rural development process. As it was found that, although the number of agricultural holdings has been decreasing, the area of agricultural holdings has been increasing. It was also found that the number of farms was decreasing, but the average farm size was increasing. This means that agricultural plots have become larger, leading to a more rational and competitive process of agricultural development. It was also found that in Kaunas district municipality the changes in the agrarian landscape and its subdivision of plots are strongly influenced by the growing population. This is also a positive aspect, as an increasing population leads to the development of rural settlements, especially in this district. In the municipality of Šilutė district, the change in the agrarian landscape and its subdivision of plots is strongly influenced by the average size of farms, which has increased by more than 71% in the municipality, which is also a positive factor for sustainable agricultural development. Of the municipalities analysed, only the municipality of Trakai district was unable to identify the most influential indicator for the change in the agrarian landscape and its plot subdivision, but it was found that the area of agricultural holdings in the municipality is increasing, which is still indicative of ongoing agricultural development.

Conclusions and proposals

1. The results of the study showed that in all the municipalities studied (Kaunas, Trakai and Šilutė districts) the agrarian landscape areas have been decreasing during the study period. The most pronounced decreasing tendencies are observed in the municipality of Šilutė district, i.e. the area occupied by agrarian landscape decreased by more than 3%, while in the municipalities of Kaunas and Trakai districts, these areas decreased quite evenly and were less than 3%. In the municipality of Šilutė district, the most pronounced decreases were observed in the area of gardens - by more than 72% - and in the area of pastures and meadows - by more than 15%, while the area of arable lands increased by more than 2%. However, the most pronounced decrease in arable land was in Kaunas district - about 4%, while in Trakai district the opposite process was observed - the area of arable land increased by almost 19%. The same reverse process was observed in the change of meadows and natural pastures, where the area of meadows and natural pastures increased by 90% in the Kaunas district during the period of study. Meanwhile, the area occupied by gardens in both Kaunas and Trakai district municipalities decreased by 79% and 89%, respectively.
2. The analysis of the changes in the agrarian landscape subdivision of plots shows that the number of agricultural holdings has been decreasing in all the municipalities studied. The largest decrease in the number of agricultural holdings took place in Trakai district, with a decrease of more than 33%, while the smallest decrease took place in Šilutė district, with a decrease of more than 15%. The largest increase was observed in Trakai district - more than 37%, and the smallest in Kaunas district - just over 5%. The average size of a farm in Kaunas district municipality remained practically stable - it increased by only 0.02 ha, i.e. by only 0.36%. Meanwhile, in Trakai district municipality the average size of a farm decreased by 2.63 ha (36.73%), while in Šilutė district municipality the average size of a farm doubled from 6.93 ha to 11.89 ha, i.e. by 4.96 ha (by as much as 71.57%).
3. After multicriteria analysis, it was found that land productivity score, population and road area have the greatest influence on the subdivision of plots of agrarian landscape and its change in Kaunas district municipality. The municipality of Trakai district, on the other hand, does not have a strong indicator, but the distance to the city centre and the area covered by protected areas have a slight influence on the change in the agrarian landscape and its subdivision of plots in this district. In Šilutė district municipality, meanwhile, the average size of farms, the number of agricultural holdings and the area covered by land and water bodies are the main factors influencing the change in the agrarian landscape and its subdivision of plots. It has also been found that changes in the agrarian landscape and its subdivision of plots in the municipalities analysed have a positive impact on the rational process of agricultural and rural development. This leads to an increase in the area of agricultural holdings and the size of the average farm and, in some cases (such as in Kaunas district), the population. The increase in these indicators leads to a competitive agricultural and rural development process.

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