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ANALYSIS OF THE LAND FUND OF THE REPUBLIC OF LITHUANIA

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Abstract The aim of the study is to analyse changes in agricultural land using recent data and to assess changes in ecological stability in Jurbarkas district. The study was carried out in the period 2010-2023. Land use area and ecological stability coefficients were calculated for the entire period, sequentially for each year. The area of tree and shrub varied considerably over the study period, ranging from 20.7 % to 60.8 %, that is, from one-fifth of the area of other land to three-thirds. The areas of wetlands, unused, and damaged land are decreasing during the study time. The urbanised areas were mainly concentrated in the areas with low ecological stability. The situation with ecological stability is not good in all the studied territories.
Key words: land fund, land use, change detection.

Introduction

Anthropogenic landscape change has been the dominant driver of landscape change in Europe for the last two millennia and more (Meyer and Turner 1994). Land use change is both a cause and a consequence of global environmental change. Land cover changes affect biogeochemical cycles, zoo and biodiversity, and contribute to climate change processes (Song et all. 2018). Anthropogenic activities associated with the redistribution of the Earth's resources have allowed humans to take land from natural vegetation and animal habitats, altering ecosystems, often to their detriment, and reducing freshwater and forest resources. While land use has long been seen as a local problem, it is becoming a global issue affecting biodiversity loss, pollution, and climate change. Humanity faces the challenge of finding a compromise between satisfying human needs and preserving ecological resources, reducing the impact on the environment (Folley et all. 2005). Land use change is driven by a synergistic combination of resource scarcity factors leading to increased production pressure on resources, changes in market opportunities, external policy interventions, loss of adaptive capacit, and changes in social organisation and attitudes (Lambin et all. 2003).

E. Tasser and Tappeiner (2002) and Tasser et al. (2007) argue that land use change is strongly influenced by road infrastructure development – if an area is accessible to transport, it is intensively used, and vice versa. Areas that are difficult to access are abandoned or used for grazing. They found that current vegetation is determined by current land use, and changes in land use determine changes in vegetation.

Over the past 70 years, land use has undergone radical changes that have significantly improved human well-being, met human needs, and promoted economic development. However, these changes have led to serious environmental problems (Perez-Soba et all., 2008; Winkler et. all., 2021). To address these problems and develop a sustainable land use model focused on natural resource management, it is necessary to study and analyse land use changes and their trends. Modelling land use change is an important way to anticipate alternative pathways into the future, through research that improves our understanding of the underlying processes of land use change (Veldkamp and Lambin, 2001).

The most common sources of land use data used in surveys are: satellite images, aerial photographs, maps and land registers. The advantages of surveys based on data from real estate registers are their relatively good availability, country-wide coverage and updating of data at regular annual intervals, as well as the direct possibility of linking data with published statistics on administrative units (Łowicki, 2008). This study will use data from the Real Estate Register, which can be accessed at https://nzt.lrv.lt/lt/statistine-informacija/lietuvos-respublikos-zemes-fondas/. Since land use and land area determine the coefficient of ecological stability of the territory and its change over time, the study determines the coefficients of ecological stability of the territory for the whole study period.

The aim of the study is to analyse changes in agricultural land using recent data and to assess changes in ecological stability in Jurbarkas district.

The objectives of the study are:

1. To assess the changes in land cover in Jurbarkas district and in the urbanised areas of Jurbarkas city and Smalininkai town in the period 2010-2023.

2. To determine the coefficient of ecological stability in the areas selected for the study and assess its change. To assess the ecological stability of the territories.

Methodology of research and materials

Monitoring of land use change is relevant for identifying major trends in land use change, analysing potential drivers of change, and tracking trends in Land Fund use and their evolution. The statistics provided by the Land Fund distinguish the following types of land use:
1. Area occupied by agricultural land:
a) Arable land
b) Orchards
c) Meadows and natural pastures
2. Forest land
3. Roads
4.Built-up area
5. Land occupied by water bodies
6. Area occupied by other land:
a) Tree and shrub plantations
b) Wetlands
c) Damaged lands
d) Unused land
The selected period is 2010-2023, i.e. the period when Lithuania has been a member of the EU for 6 years already. EU payments and requirements for agriculture have already been partially established, but changes in them and in socioeconomic factors have influenced and continue to influence land use change.
The study area is Jurbarkas district, located in the south-western part of the country. The southern part of the district borders the Nemunas River, the largest river in Lithuania.

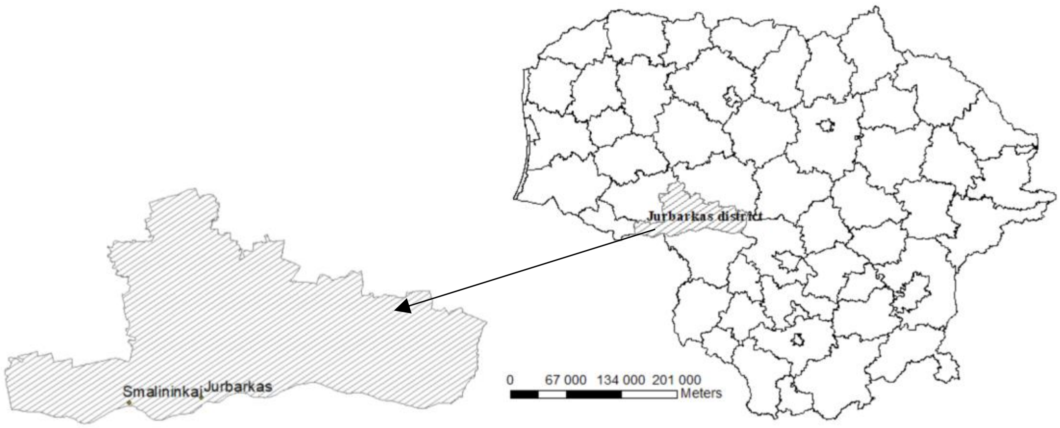


Figure 1: Administrative division of the Republic of Lithuania; Jurbarkas district

The district covers an area of 1507 km2 and is located in the Karšuva Lowland, where the Earth's surface slopes downwards from north-east to south-west, from 90 m in the eastern part of the district to 8 m near the Nemunas River. The population density is 17 inhabitants per km2. The soil of the district has one of the highest productivity scores in the republic, 49.77, and the conditions for agricultural activity are particularly favourable. In the western part of the district, where the land productivity is the lowest in the district, there is the Karšuva Forest. In the southern part, there are practically no forests along the Nemunas River.
During the research, the data of the Land Fund of the Republic of Lithuania were analysed using comparative and graphical methods, as well as the latest data.
An assessment of the changes in the ecological stability of the district territory during the selected period was carried out. Ecological stability was calculated according to the formula (P. Aleknavičius, 2008):

$$K_e = \frac{\sum(K_{es} * p_i)}{\sum p_i}$$

here Kes – coefficient of ecological stability of the type of land use, pi – area occupied by the type of land use, ha.
Territory is called ecologically stable when the ecological stability coefficient of the territorial unit is $K_e \geq 0.67$. A moderately stable territory is considered to have a coefficient of 0.51-0.66, a low stable territory has a K_e of 0.34-0.50 and an unstable territory has a K_e of 0.34.

Discussions and results

An analysis of the land use statistics provided by the Land Fund was carried out. The area of agricultural land in relation to the area of the district was calculated (Figure 2).

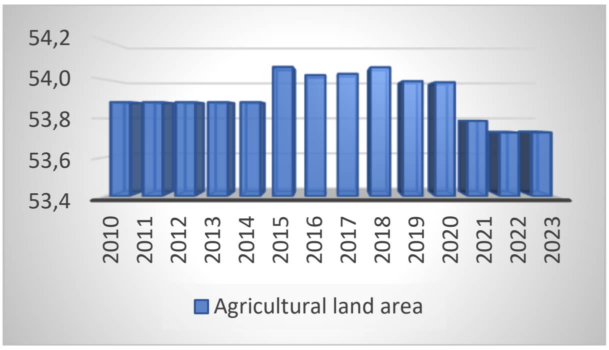
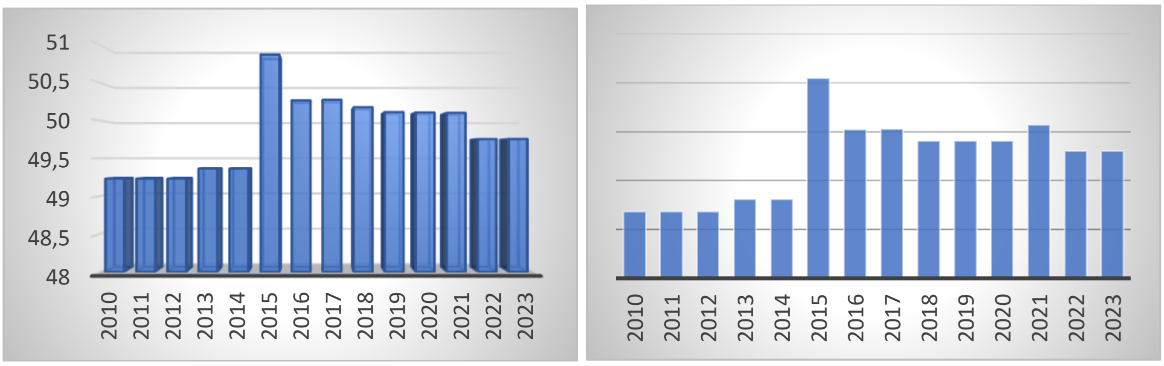


Figure 2. Agricultural land area, in percent

The predominantly fertile soils of the district make it favourable for agricultural activities. Figure 2 shows that land of this type occupies more than half of the total area of the district. Over the entire 13-year study period, the area varied from 53.7% to 54.1%. There is a slight increase from 2015 and a decrease from 2021. From 2022, the area of agricultural land is at its lowest level over the entire period, but this is a very small change of 0.4%.
The area of arable land, orchards, meadows and natural pastures as a percentage of the total area of the district and of agricultural land was calculated (Figure 3):



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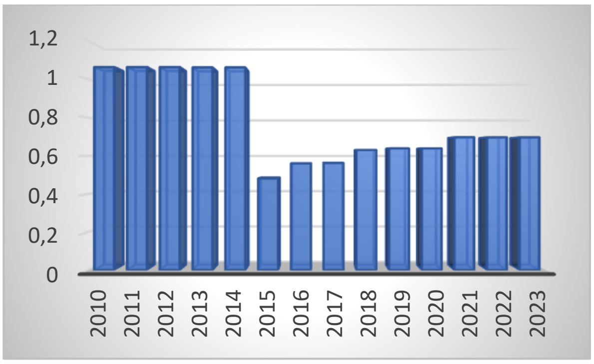

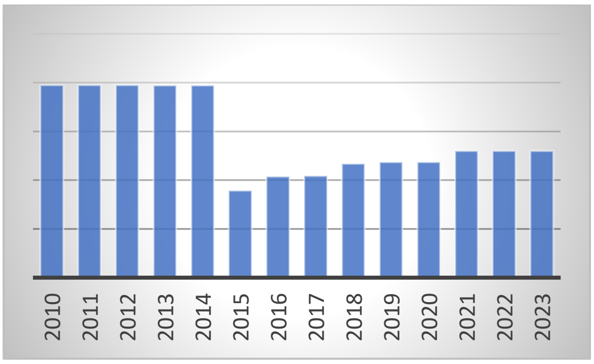

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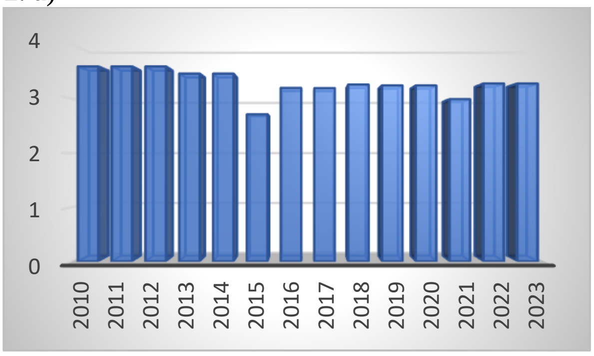
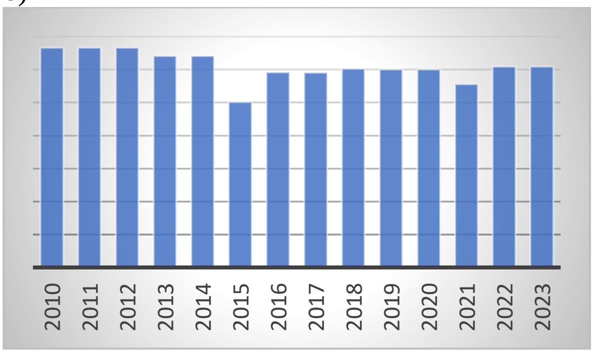




3. a) b)

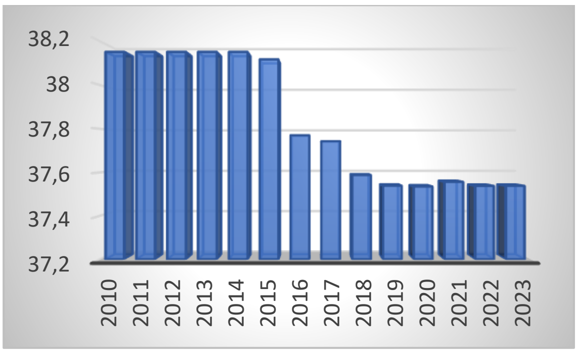
Figure 3: Proportion of cultivated agricultural area: 1. arable land, 2. orchards, 3. meadows and natural pastures; a) as a percentage of district area, b) as a percentage of total cultivated area

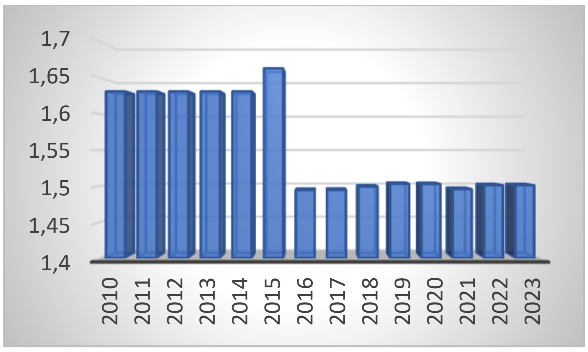
Arable land accounts for the majority of agricultural land (significantly more than gardens, meadows, and natural pastures), from 91.4 % (2010) to 94.1 % (2015). From that year onwards, the share of arable land declined slightly to reach 92.6 % in 2023. Despite the decrease observed since 2015, the area of arable land has increased by 725 ha over the whole 13-year period. Arable land accounted for 49.2 %-50,3% of the district area.

Gardens make up a very small proportion of agricultural land – only 1,2 -2 %. The area has decreased more than twice since 2015, from 2 % to 0.9 %. There has then been a slight increase to 1.3 %, but the original level has not been reached. As a proportion of the district's area, these areas cover between 0.6 % and 1.1 %. The area of gardens in the district is very small and there is no clear upward trend.

Meadows and natural pastures account for only 5.0 %-6.7 % of the agricultural area. This is more than the area occupied by orchards, but not as significant overall. For the district, the figure is only 2,7-3,6 %. The area of meadows and natural pastures has declined despite EU efforts to retain permanent pastures, greening payments since 2012 and the requirement for ploughing.

The share of other agricultural land in the area of the district is presented in Figure 4.





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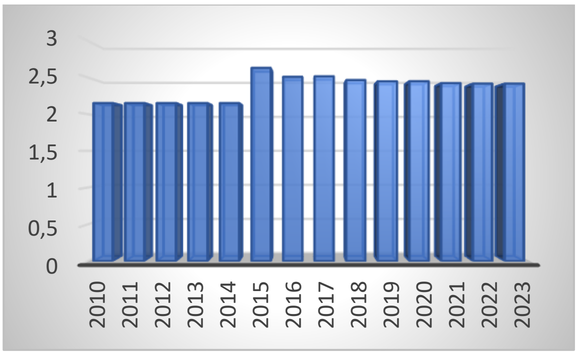

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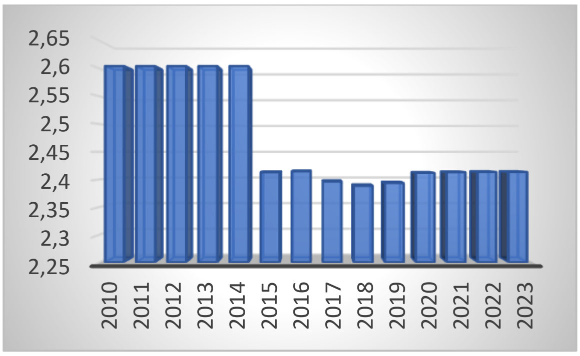

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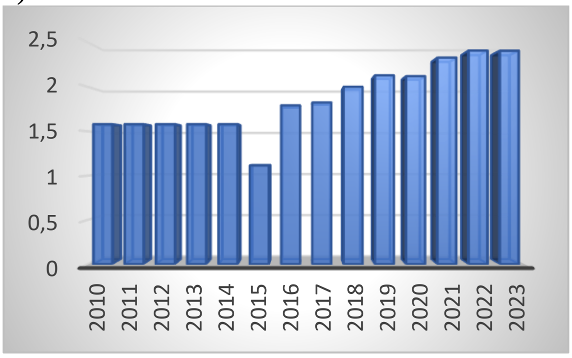
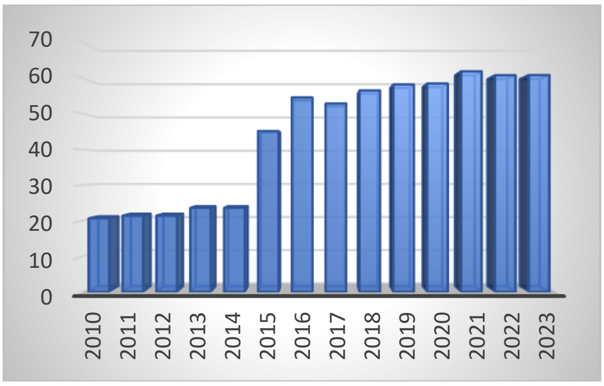


e)

Figure 4. Agricultural land as a percentage of district area: a) forest land, b) roads, c) built-up area, d) land occupied by water bodies, e) other land

Forest land occupies 37,5 %-38,2%. Since 2016, the area of forest land has steadily decreased from 38,3 % to 37,5%. Roads have also declined since 2016 by 0,1%. The built-up area has increased by 0.4 % since 2015, and has slightly decreased (0.2 %) since 2018. The water bodies have decreased by 0.2 % since 2015. The area of other land has varied between 1.6 % and 2.4 % over the period under study. In 2010 these areas were 1.6 %, in 2015 they dropped to 1.1 % and since 2016 they have increased steadily from 1.8 % to 2.4 %.

The study further determined the percentage composition of other land components in relation to its area and to the area of the district (Figure 5).



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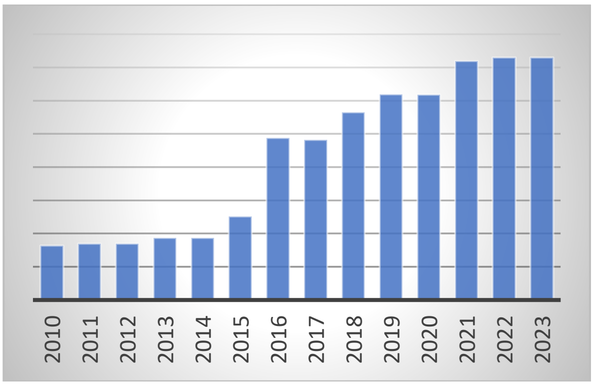

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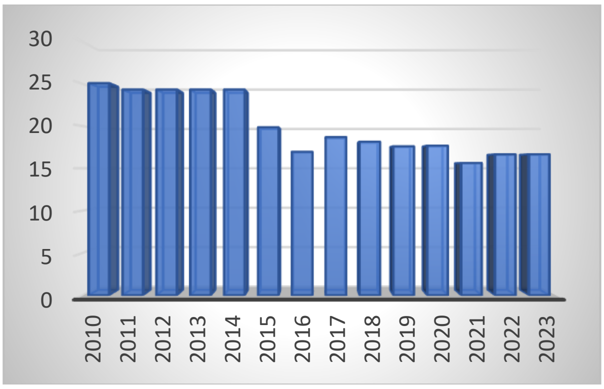

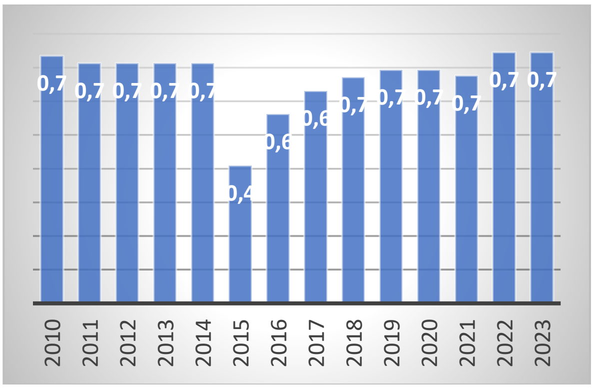

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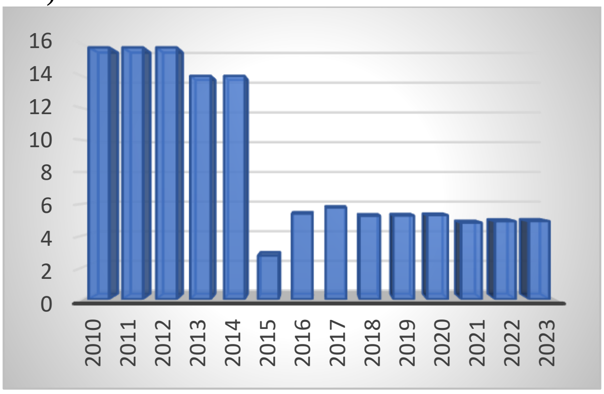

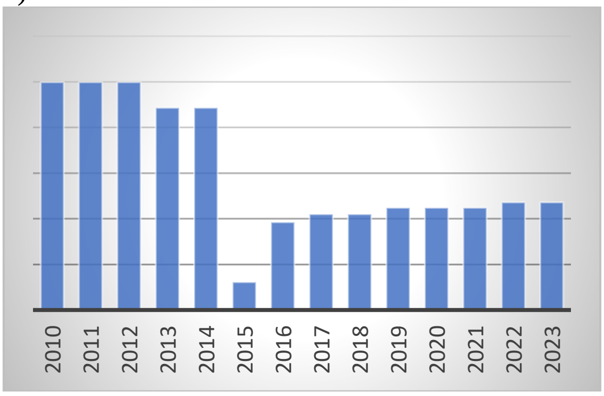

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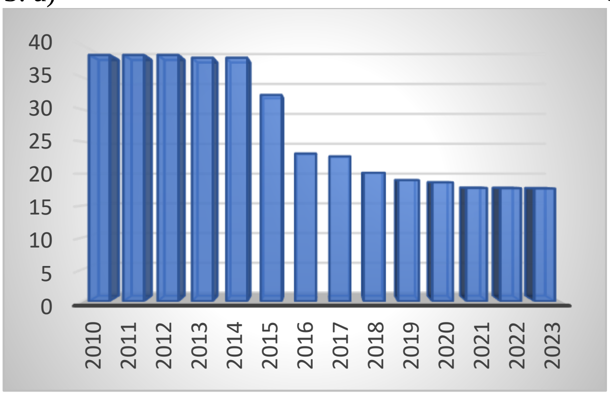

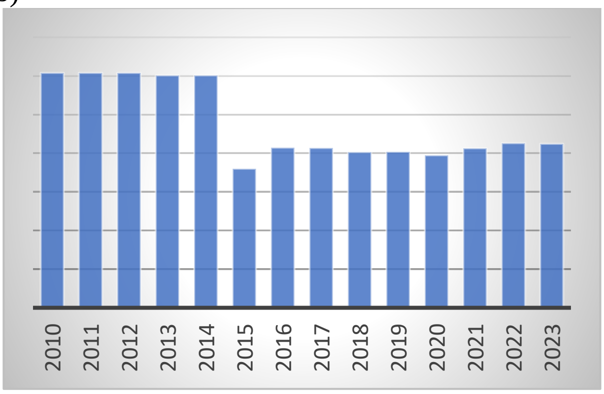

4. a) b)

Figure 5: Proportions of other land: 1. shrubland, 2. wetlands, 3. damaged land, 4. unused land; (a) as a proportion of total other land area, (b) as a proportion of district area

The largest proportion of other land in 2023 is shrubland and unused land. The area of tree and shrub plantations varied considerably during the study period, ranging from 20.7 % to 60.8 %, that is, from one fifth of the area of other land to three fifths. However, in terms of the area of Jurbarkas district, this figure ranged from 0.3 % to 1.5 %. Thus, at the district level, the area of these territories is very small. The area of wetlands, unused and damaged land is decreasing during the study period. Unused land in 2010 was 38.5 % of other land area and in 2023 it was only 17.7 %, which was only 0.4 % at district level.
The area of damaged land decreased from 15.8 % to 4.9 %, which is 0.2 % (2010)-0.1 % (2023) for the district.
As a follow-up study, ecological stability coefficients were calculated for the whole period, sequentially for each year. Ecological stability coefficients for soil types are presented in Table 1.

1 Table

Ecological stability coefficients

Land use types	Ecological stability coefficient of land use type
Arable land	0.14
Orchards	0.43
Meadows and natural pastures	0.65
Forest land	1.00
Roads	0.00
Built-up area	0.00
Land occupied by water bodies	0.79
Tree and shrub plantations	0.40
Wetlands	0.79
Damaged lands	0.00
Unused land	0.68

The resulting changes in ecological stability are presented in Figure 6.

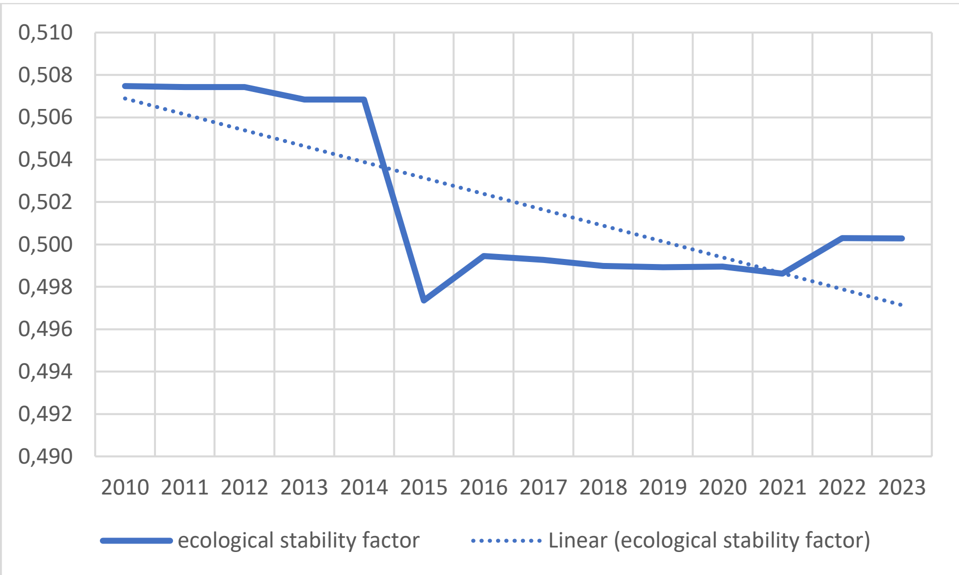

Figure 6: Changes in ecological stability in Jurbarkas district

From 2010 to 2015, Jurbarkas district was considered a moderately stable territory. Since 2015, the coefficient of ecological stability decreases from 0.51 to 0.49 and the territory becomes low stable. From 2022, the coefficient increases to 0.50 but does not reach the level of 0.51 to be classified as a moderately stable area. Reducing the area of arable land by 3,000 ha at the expense of 3,000 ha of grassland would move the area into the moderately stable category. However, this would require a change in the nature of agricultural production, which is unlikely.

Land Fund statistics show land areas in two towns in Jurbarkas district. Therefore, the study was continued to identify changes in the land area and ecological stability coefficients of Jurbarkas city and Smalininkai town of Jurbarkas district.

In Jurbarkas (Figure 7), the largest areas are occupied by built-up areas. During the period under study it decreases from 44.7 % to 33.4 %. Agricultural land is increasing from 14.2 % to 22.0 %.

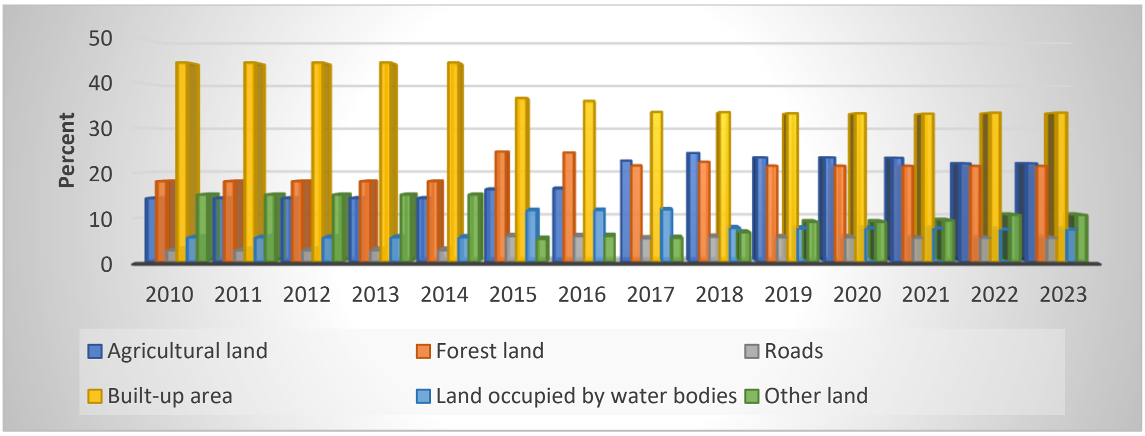

Figure 7. Change of land use in Jurbarkas from 2010 to 2023.

The area of forest land is also increasing from 18.0 % to 21.5 %. Road and water areas are also increasing, from 2.6 % to 5.4 % and 5.5 % to 7.3 % respectively. The area of other land decreases from 15.0 % to 10.5 %.

Calculated coefficients of ecological stability of Jurbarkas city, in 2010-2023.

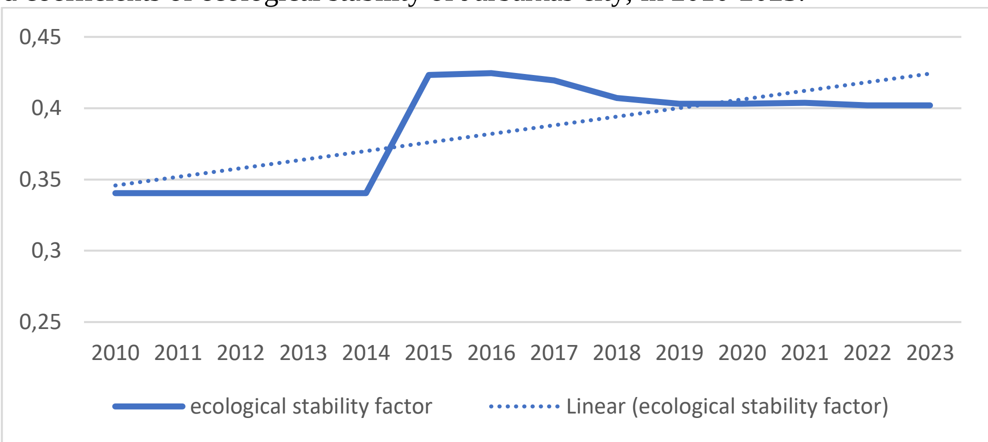

Figure 8: Changes in ecological stability in Jurbarkas

Jurbarkas is considered to be a low stability area. Since 2010, the ecological stability coefficient increases from 0.34 to 0.42 (2015), but the value of the coefficient subsequently decreases and reaches 0.40. Throughout the period under consideration, the ecological stability coefficient does not rise to 0.51 to place the city in the category of moderately stable area.

In Smalininkai (Figure 9), unlike in Jurbarkas, the built-up area increases from 22 % to 43 % – almost doubling. The number of roads is increasing from 3.2 % to 5.3 %. Agricultural land is increasing from 19.3 % to 38.2 %. The area covered by water increased from 1.0 % to 2.7 %.

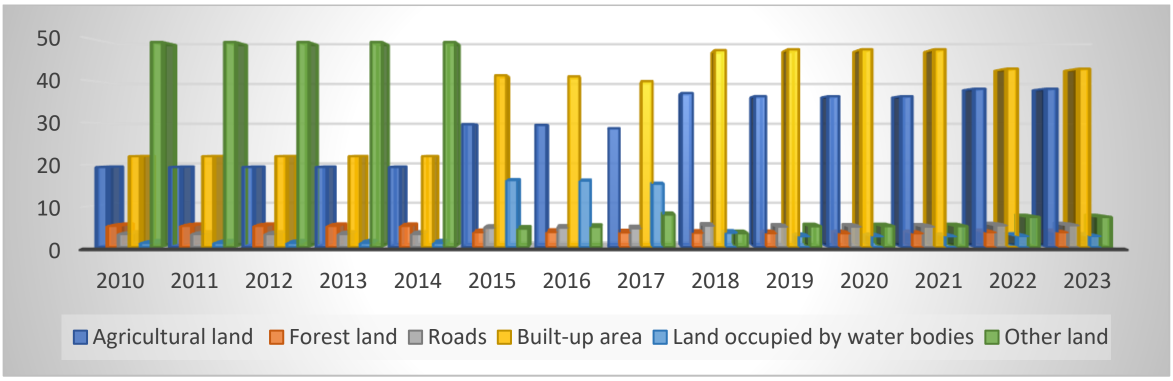

Figure 9: Land cover change in Smalininkai in 2010-2023

The area of land with high ecological stability, such as forests and other land, has declined. The area of forest has decreased from 5.1 % to 3.6 %. Other land decreased from 49.4 % to 7.3 % . The situation in this town in terms of the change of land use types is quite different from that of Jurbarkas. As a follow-up to the study, the ecological stability coefficient (Figure 10) was calculated for the period under study.

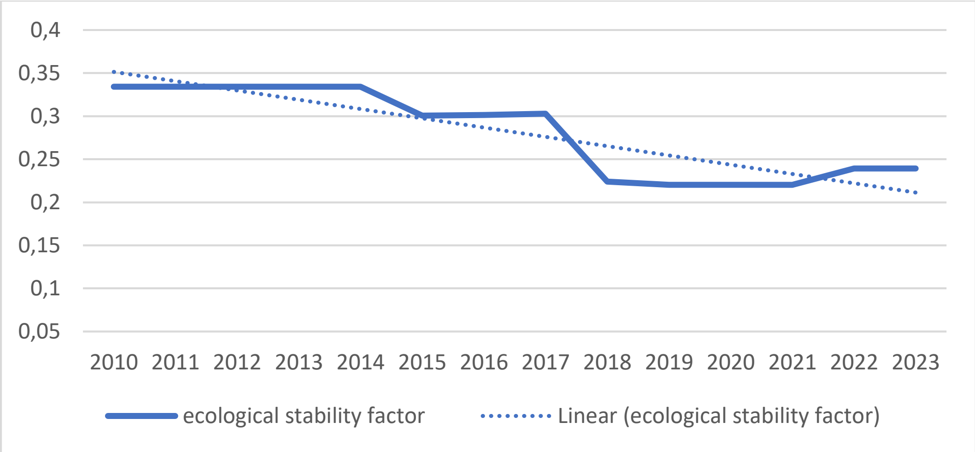

Figure 10: Changes in ecological stability in Smalininkai

The territory of Smalininkai is considered to be ecologically unstable throughout the whole study period. In 2010, it was still on the borderline of low stability, with an ecological stability coefficient of 0.33, close to the threshold of 0.34, which would make it low stable. As time went on and changes in land cover continued, the ecological stability of the urban area only decreased, reaching a coefficient of 0.22. From 2022 onwards, the ecological stability coefficient has risen above 0.02 to reach 0.24.
The ecological stability coefficient for the whole study area has been decreasing. Whereas an agrarian area is moderately ecologically stable, the situation is different in urbanised areas. The situation in Jurbarkas is better and positive trends can be observed there. However, in Smalininkai the ecological stability is only decreasing.

Conclusions and proposals

1. More than half of the territory of Jurbarkas district is occupied by agricultural land (53.7 %), of which 92.6% is arable land. Forest land accounts for the second largest area – 37.5%. However, while arable land area is increasing, forest land area is decreasing. Other land areas are small and account for only 8.7% of the total area. Due to the distribution and changes in the area of these land uses, Jurbarkas district is considered a district with low ecological stability. Until 2015, the district was classified as moderately ecologically stable.
2. The city of Jurbarkas belongs to the territories with low ecological stability throughout the study period. Since 2015, the coefficient of ecological stability increases from 0.34 to 0.41 and then slightly decreases to 0.40. The town of Smalininkai belongs to ecologically unstable areas throughout the study period, with the ecological stability coefficient, which was low in 2010, decreasing from 0.33 to 0.24.
3. The situation with ecologicall stability is not good in all the studied territories. In urbanised territories the situation is much worse than in non-urbanised ones. In Jurbarkas district the ecological stability has decreased but stabilised. The situation is particularly bad in Smalininkai, where ecological stability has remained stable throughout the study period. While in Jurbarkas the situation is improving, in Smalininkai the ecological stability of the area is deteriorating.

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