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URBAN DEVELOPMENT: HOW AGRICULTURAL LAND USE IS CHANGING?

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Changing human needs lead to a changing landscape and land use. Recent years have seen active urban sprawl, infrastructure development projects and intensive urban expansion. These processes have a direct impact on agricultural land, some of which is being taken out of active farming and converted to other uses. Changes in land use are reflected in the annual statistics on agricultural land and crop declarations, which show a decrease in the number of applications and the areas declared. The impact of urbanization is not only visible in urban areas, but also in rural areas, where, as residential areas expand, some rural areas are becoming increasingly urbanized, losing their traditional agricultural functions. The aim of this research is to analyze how agricultural land use is changing under the influence of urban development and to identify the main trends and consequences of these processes over the period 2015–2024. The study applies GIS-based spatial and statistical analysis using GIS software to explore the relationship between urban growth and the decline of agricultural areas.

Keywords: *agricultural land, ArcGIS Pro, GIS technology, land use change, land use planning, remote sensing, spatial analysis, sustainability, urban development, urbanization*

INTRODUCTION

Agricultural land is very important for Lithuania's wealth and economic development. The use of this land is mainly related to food production, rural development, and environmental conservation. Agriculture remains a key economic sector, facilitating food supply and rural development. Agricultural land is a limited and practically non-renewable resource, so it is very important to preserve and use it properly (Šalkauskienė et al., 2019). Urban expansion is a main factor in land use changes, often resulting in the conversion of agricultural land into built-up areas. Rapid urbanization causes fierce competition, increased demand for built-up areas, and the need to conserve agricultural land, forests, and arable land. As a result, recognizing the ongoing expansion of land resources has become quite difficult (Aziz et al., 2022).

Effective land resource management is essential for economic liveability and environmental sustainability. Usage trends are changing due to a variety of economic, political, and environmental influences, and factors such as urbanization, climate change, economic regulations, and advances in agricultural technology have a direct impact on changes in agricultural land (Sužiedelytė Visockienė et al., 2018). The rate of decrease in the area of agricultural land surrounding the city has been consistent and ongoing, a consequence of the urbanization that has spread beyond the city's boundaries and the increase in the rate of urbanization. These processes have resulted in mounting pressures on the city due to population growth. The city is an area of reconstructed environment, where technological (built) and natural environment must not be contrasted (Deveikienė V., 2020). Moreover, the rise in population leads to an increase in demand for land for housing and other human services, which will have a significant impact on agricultural lands. The lack of proper planning in the city contributes to expanding urbanization at the expense of agricultural land (Aziz et al., 2022); (Escandon - Panchana et al., 2024).

The spatial data set of control land areas in the territory of the Republic of Lithuania at a scale of 1:5,000 is one of the main sources of geographic data that allows for a detailed analysis of land use distribution and changes in Lithuania. KŽS_DB5LT is a land parcel identification and registration system consisting of graphic and attribute data. Lithuanian block database contains information about cultivated land blocks, built-up area blocks, forest land blocks, and mixed-use area blocks. This makes it possible to determine what changes are taking place in certain areas, whether cultivated land areas are decreasing or urbanized areas are increasing. The spatial data in this database helps to accurately identify land use trends and make data-driven decisions. GIS technology helps farmers and agricultural managers make informed decisions by providing spatial data and analysis tools (Hasna et al., 2023); (Huang et al., 2016). These systems can be presented on websites, thus making accessibility and cooperation broader and simpler. When analyzing these changes, it is necessary to rely on statistical data that allows for an assessment of the real situation and long-term tendencies. Statistical data from the Agricultural Data Centre, covering the number of applications submitted and the areas of land

declared, allow us to analyze how the areas of land declared by farmers are changing, how the number of applicants is changing, and what tendencies can be observed over several years. This data is particularly important for assessing changes in the use of agricultural land and for making strategic decisions on agricultural policy and rural development.

RESEARCH METHODS

The aim of the research is to analyze how urban development affects agricultural land use and to identify the key spatial and statistical trends in these changes. Globally, agriculture and related activities generated US$3.5 trillion in value added between 2000 and 2019, representing a 73% increase. The sector also provided employment for 874 million people, underscoring its important role in the global economy (Rani et al., 2023). The contribution of agriculture to GDP varies greatly between regions and countries, as it depends on their economic structure and level of development. The added value of EU agriculture per employee is closely linked to GDP per capita, which shows that agriculture can stimulate economic growth and act as a stabilizer during economic crises. (Apostolidou et al., 2015) Despite representing a relatively modest percentage of GDP in many developed countries, agriculture performs an essential function in the economy and society. In the European Union, for instance, the sector contributes approximately 1.3% to GDP. However, its importance extends far beyond this figure. Agriculture plays a pivotal role in ensuring food security, supporting rural communities, and providing raw materials for various industries. The impact of agriculture on employment is significant, with millions of individuals still engaged in farming activities across the European Union. The sector also exerts an indirect influence on food processing, logistics, and retail. Furthermore, agriculture is inextricably linked to environmental sustainability. The management of agricultural practices has a significant impact on land use, biodiversity, and climate change mitigation. Despite its declining proportion in the economic structure, agriculture remains an essential foundation for balanced development, combining economic, social, and ecological dimensions (Eurostat, 2025) In Lithuania, the agricultural sector remains one of the main components of the national economy. The gross value of agricultural output (GVA) – an indicator showing the total annual value of goods and services produced in the agricultural sector – amounted to EUR 1,114.3 million in 2024, which is slightly less than in 2023 (EUR 1,126.7 million) and notably lower than in 2022 (EUR 1,246.9 million). The highest value of agricultural production in the period under review (2015–2024) was recorded in 2022. Crop production has fluctuated significantly in recent years. In 2022, its value reached EUR 565.0 million, but by 2024 it had fallen to EUR 426.2 million. Previous data show that in 2020, crop production amounted to EUR 370.5 million, and by 2022 it had decreased slightly (0.2%) to EUR 369.7 million. These figures demonstrate the dynamism of Lithuanian agriculture and reflect general EU trends, where productivity and production are closely linked to environmental and market conditions (*Official Statistics Portal, 2024*).

C. Jayadevan's research shows that the transition from an agricultural to a modern economy depends heavily on industrialization and urbanization. These processes influence agricultural development in multiple ways. Industrialization provides farm machinery and equipment for mechanization, as well as irrigation infrastructure. It also increases the production and use of fertilizers, all of which boosts agricultural productivity. Urbanization stimulates the demand for agricultural products, whether raw or processed, for direct consumption or as industrial raw materials. Although industrialization and urbanization reduce the percentage of people employed in agriculture and the amount of agricultural output, they increase the percentage of cultivated land and the overall production of food and livestock. This study provides new empirical evidence demonstrating the significant and complex role industrialization and urbanization play in shaping agricultural development (Jayadevan, C. M. 2020); (D'Agata, S. & Maina J. M., 2022). Although the population in Lithuania continues to decline, the level of urbanization is increasing due to migration from rural areas to cities (Lisovskė, R., & Gurskienė, V., 2024).

The Law on Land of the Republic of Lithuania and the provisions and regulations governing the determination of real estate are fundamental legal acts regulating land ownership, management, and use in the country. This legal system not only provides clarity on legal issues but also promotes the rational use of land resources and environmental protection.

The Land Law of the Republic of Lithuania establishes the principles of land use, protection, and administration, which aim to facilitate rational and sustainable agricultural practices. The laws define various categories of land use, the procedures for changing them, ownership structures, and establish the basic principles on which the organization of land use is based. The main objective of this statute is to promote sustainable progress in land use while conserving land resources, maintaining fertile soil, and mitigating the environmental impact of urban development and other economic activities. The law applies to owners and users of state, private, and municipal land holdings (Seimas of the Republic of Lithuania (Lietuvos Respublikos Seimas), 2025). Land is divided into categories for agriculture, forestry, conservation, aquaculture, urban areas, and other functions. The intended use of land is determined in accordance with the relevant planning documents for the respective territories. The Law on Land of the Republic of Lithuania and the provisions and rules for the establishment of real estate are essential legal acts regulating land ownership, management, and use in the country. This legal system not only provides clarity on legal issues but also promotes the rational use of land resources and environmental protection. Cadastral data is also used to monitor changes in land use and assess potential negative impacts on the environment, ensuring a sustainable and responsible use of land. The use of geographical information system technologies allows for the visualization of cadastral data and facilitates a detailed analysis of land use. Cadastral data facilitates the accurate identification of individual land parcels, enabling the determination of their boundaries, area, intended use, and ownership rights.

This information is very important when carrying out procedures related to the consolidation and division of land plots, the establishment of agricultural enterprises, the registration of land leases, and other land-related activities (Ministry of Environment of the Republic of Lithuania, 2024). The agricultural cadastre plays an essential role in land

administration systems because it achieves the spatial integrity of farming parcels, guaranteeing food security, agricultural production and land tenure. Cadastral data ensures the spatial integrity of farming parcels, which is essential for guaranteeing food security, agricultural production, and land tenure (Escandon - Panchana et al., 2024).

The cadastral system in Lithuania plays an important role in registering changes in land use and assuring compliance with environmental regulations. This includes procedures for the use, updating, and maintenance of accurate spatial data. The provisions of the Law on Real Estate Cadastre of the Republic of Lithuania increase the efficiency of land use, urban planning, and real estate rights protection. GIS technologies are also used for crop monitoring and yield estimation. This includes monitoring crop variability, predicting yields, and identifying areas affected by diseases or pests. One of the most used GIS platforms is ArcGIS Pro software, which allows data analysis, thematic map creation, and spatial research. High-resolution satellite and drone imagery is increasingly being used in precision agriculture to monitor crop and soil conditions in detail. These technologies offer cost-effective and flexible data acquisition solutions (Huang et al., 2016).

Urbanization, as a many-faceted process, encompasses not only population growth but also changes in land use, which can have a long-term impact on both the ecological and economic environment. Changes in land use are determined by human activity, which alters not only the landscape but also infrastructure, transport networks, social services, and the nature of economic activity, and this can have both positive and negative consequences (Ivavičiūtė, G. 2025). Land use change often occurs due to the expansion of settlements, which is driven by investors, but this expansion does not always correspond to real market demand. The most negative impact is caused by urban development, when architectural solutions are not based on sustainability principles and international standards. In such cases, insufficient consideration is given to the preservation of cultural heritage and the importance of agricultural areas, which can lead to inefficient land use and long-term negative consequences for both the environment and local communities (Gaudėšius, R. 2015).

RESEARCH RESULTS AND DISCUSSION

One of the main challenges of urbanization is the increasing pressure on land use and land cover. Intensive development can lead to a reduction in arable land, the disappearance of natural ecosystems, and a decline in biodiversity. Therefore, targeted and systematic land use planning becomes particularly important to reconcile urban development with environmental requirements. Geographic information systems are one of the most advanced tools for better understanding and managing these processes. GIS also allows us to visualize urban growth trends, identify the most vulnerable areas, and optimize infrastructure development to reduce negative environmental impacts (Hasna et al., 2023).

GIS systems can be used to create detailed maps that help predict future urban development scenarios, assess their impact on the environment, and provide sustainable solutions. This ensures balanced urban growth, taking into full consideration both economic and ecological aspects. The obtained GIS layers were analyzed to identify areas converted from agricultural to urban or built-up use. Statistical comparisons were made to evaluate long-term tendencies and correlations between urban growth and agricultural land reduction. A study of the urbanization process using spatial data and statistical information collected from geoportal.lt – 2022 population data and a layer of control land plots (Fig. 1) – opens new perspectives for analyzing and forecasting urbanization trends in Lithuania.

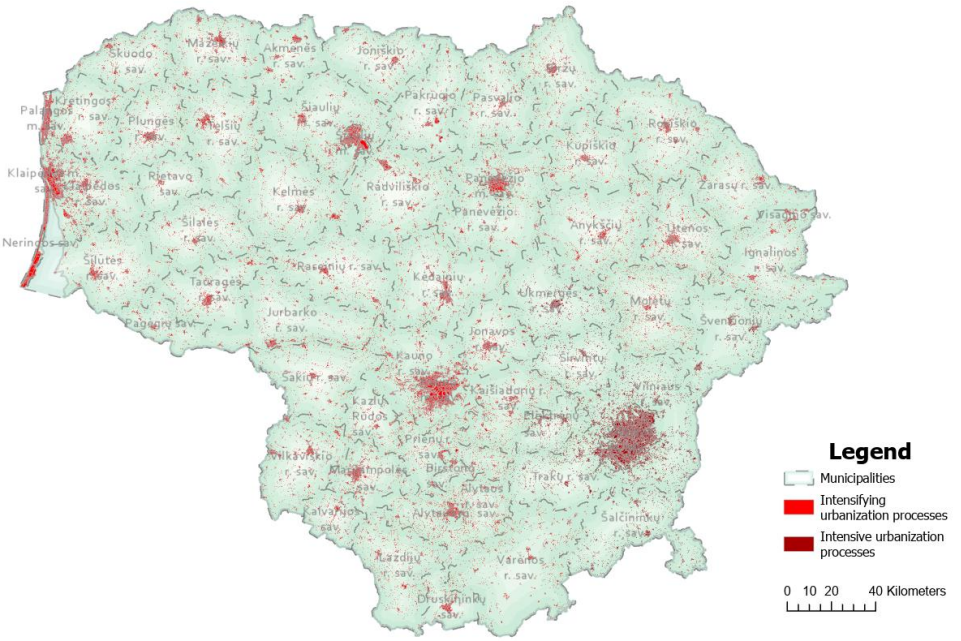
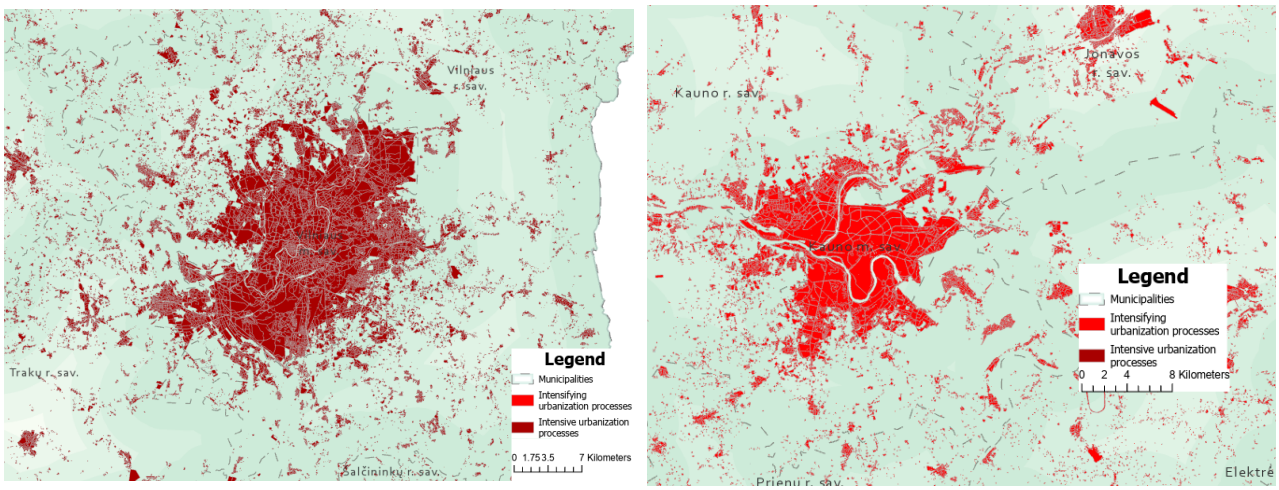


Figure 1. Urbanization processes in Lithuania.

This data allows us to monitor the distribution of the population in Lithuania and its possible impact on land use, with particular attention to changes in agricultural land. In suburban areas and rural areas, there is a trend towards the formation of denser settlements, with urbanized areas gradually expanding into previously less populated or agricultural

areas (Spirkova et al., 2020). Data were obtained from official national land use statistics, crop declarations, and remote sensing sources for the period 2015–2024. Spatial analysis and visualization were performed using ArcGIS Pro software.

Considering the increasing urbanization process, it can be predicted that in the future more territories will be affected by urbanization and infrastructure projects, which will directly impact agricultural activities. At the national level, Vilnius, Kaunas, and Klaipėda stand out as European-level urban centers. Neighboring districts are strongly affected by urbanization, with residential areas rapidly expanding in locations lacking proper engineering infrastructure or city communications. Therefore, to plan territories effectively, it is necessary to analyze the urbanization process and assess the development potential of these areas (Lisovskė & Gurskienė, 2024) The suburbs of major Lithuanian cities, especially Vilnius, have experienced significant population growth (Fig. 2 (a)). This growth is characterized by scattered residential areas and a growing need to create diverse living spaces that reflect changes in people's lifestyles. Such development of settlements requires new construction to meet the growing needs of the population and ensure a comfortable life.



a **b**

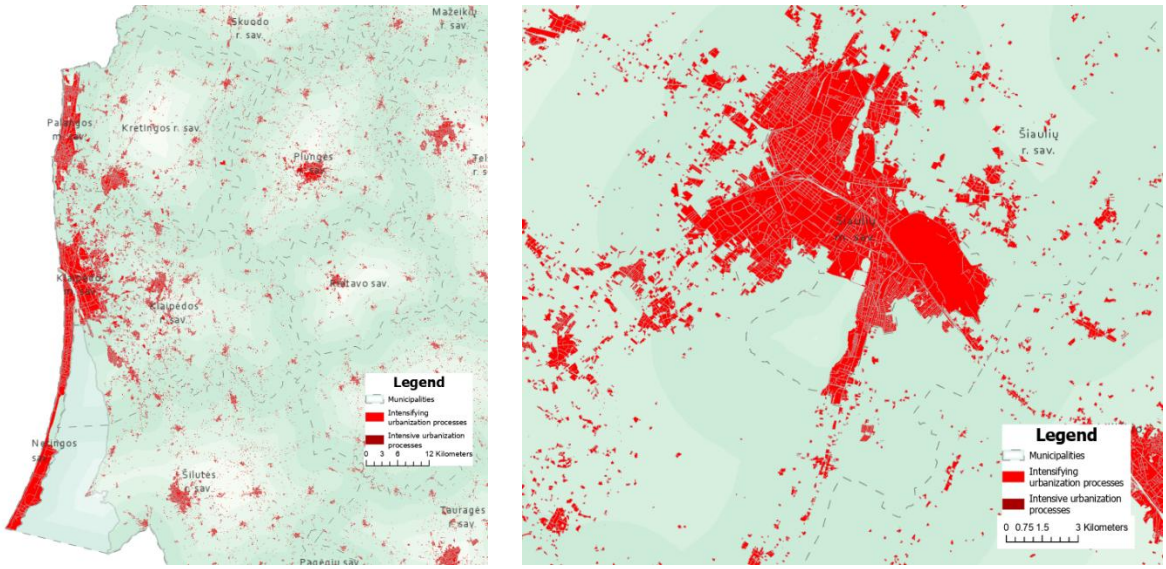
Figure 2. Urbanization processes. Panel (a) shows urbanization in Vilnius district. Panel (b) shows urbanization in Kaunas district.

The development of built-up areas in Vilnius, Kaunas, Klaipėda and Šiauliai is clearly reflected in the data analyzed. The pace of urbanization in these cities is rapidly increasing due to population growth, economic development and infrastructure improvements. In Vilnius, urban development is particularly evident in the southern and western suburbs, where new residential areas and commercial zones are being formed. In Kaunas, there is a notable increase in the development of built-up areas in the surrounding districts. This development encompasses individual housing estates and logistics centers, which are being constructed in accordance with the city's growing economic activity (Fig. 2 (b)). Urbanization processes in Klaipėda are concentrated in the eastern parts of the city and its suburbs, where new residential neighborhoods and industrial zones related to port activities are being developed (Fig. 3(a)). Signs of intensified urbanization processes are discernible in both the central districts and the peripheral suburbs of Šiauliai. The expansion of the city has been substantial, with new residential and industrial zones emerging in the eastern and southern regions. The city's periphery exhibits indications of suburbanization, as evidenced by the presence of scattered built-up areas, indicative of the transition from urban to suburban living. This phenomenon is further substantiated by the increasing prevalence of individual housing units, suggesting a shift towards more dispersed residential patterns. The development of industrial and commercial infrastructure has further stimulated the city's spatial growth, consolidating Šiauliai role as a regional economic center (Fig. 3(b)). The development of these cities is characterized by scattered urban growth, often with limited urban planning intervention, Therefore, it is important to ensure balanced territorial development in the future, maintaining a harmonious balance between urbanization and the preservation of natural and agricultural areas.

According to a study by Lisovskė and Gurskienė, the level of urbanization in Lithuanian counties varied between 2012 and 2023. Urbanization increased steadily in Šiauliai and Tauragė counties, while it decreased in Kaunas and Klaipėda counties. After calculating the changes in urbanization from 2012 to 2022, it was found that the highest growth occurred in Tauragė County (9.79%), followed by Šiauliai County (8.83%). According to forecasts for 2030, urbanization is expected to increase in five counties, while in the remaining counties it is expected to remain relatively stable or decline (Lisovskė & Gurskienė, 2024).

In Lithuania, agricultural land constituted 51.64% of the total territory in 2024, yet in recent years a concerning trend of decline in this share has been observed. The reduction in agricultural land is largely driven by two key factors: the expansion of urbanized areas and the growing promotion of afforestation initiatives on former agricultural plots. Previous studies have also documented significant decreases in these land use categories, which in some cases may be linked to natural processes. According to data from the Land Fund, this dynamic underscores the need for comprehensive monitoring of land use changes and their long-term implications for agricultural production, environmental balance, and sustainable land management. Accounting data, in 1946, a comprehensive total of 4,278,000 hectares of agricultural land was delineated in Lithuania. Of this total, 2,966,300 hectares were categorized as arable land. A total of 41,900 hectares were designated for orchard cultivation, 789,600 hectares were allocated for meadow grazing, and 486,500 hectares were

set aside for pastureland. By 2016, the total area of agricultural land had diminished to 846.5 thousand hectares, indicating a 19.8% reduction (Aleknavičius, M., & Aleknavičius, A., 2017).



a **b**

Figure 3. Urbanization processes. Panel (a) shows urbanization in Klaipėda district. Panel (b) shows urbanization in Šiauliai district.

According to data from Land Fund, this area has decreased by 1.5% over the past nine years, from 2015 to the beginning of 2024 (Land Fund, 2025). The main reasons for the decline are not only urbanization, the increasing expansion of cities but also other factors such as infrastructure projects, the development of industrial zones, reforestation, soil erosion, and climate change. This decline has significant consequences. The decline in agricultural land causes food prices to rise, reduces the number of jobs in rural areas, increases dependence on imports, and negatively affects the stability of ecosystems and biodiversity. However, given limited land resources and stricter land-use planning policies, it is likely that this decline will slow down or stabilize in the future (Innovation Agency, 2023). In addition, new technologies, agricultural intensification, and state support can help preserve agricultural land and ensure the development of the agricultural sector in the country.

Information related to land use and changes in Lithuania can also be accessed from the country's spatial information portal geoportal.lt, an information system established by the Law on Geodesy and Cartography of the Republic of Lithuania, which integrates the state's spatial data and services, supports tools and environments for using these resources, and provides users with access to spatial data and maps in one place (Ministry of Environment of the Republic of Lithuania, 2024).

Based on statistics showing the number of applicants, there is a downward trend in the number of applications in Lithuania from 2015 to 2024 (Table 1).

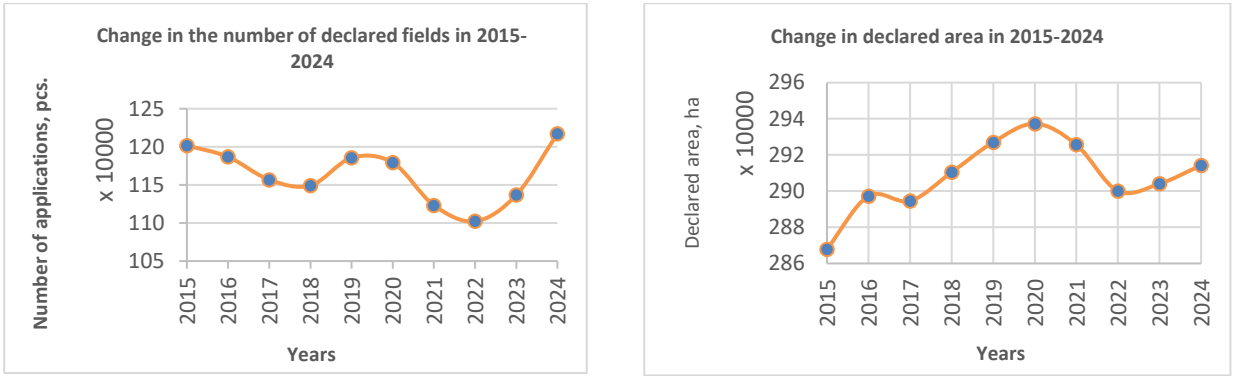
Table 1. Change in the number of applications.

Indicator	Value
Average number of applications per year	126 345
Highest number of applications per year	139 527 (2015)
Lowest number of applications per year	113 000 (2024)
Application change from 2015 to 2024	-26 527 (-19%)

The number of applications in cities has practically disappeared, and currently all applications are submitted only in rural areas. This reflects a general change in the distribution of agricultural activity – farming is becoming extremely rare in cities, and the main economic activity is concentrated in rural areas. The decline in population and the aging of society in rural areas may be one of the reasons for the decline in the number of applications. Climate change is also a challenge for agriculture.

Figure 4 (a) clearly shows the changing trend in declared fields. Initially, from 2015 to 2017, the number of declared fields was stable, fluctuating between approximately 1,186 thousand and 1,202 thousand. Later, from 2017 to 2022, a decline was observed, followed by a significant increase from 2022, especially in 2024. This period is characterized by rapid growth. A particularly large jump is seen in 2024. Possible reasons for this may be new support programs or simplified declaration procedures, allowing farmers to declare their cultivated areas more easily and quickly.

This leads to the conclusion that the number of declared fields in Lithuania has undergone significant changes over the last decade. From a period of stability to a steady decline and then a sharp increase.



a **b**

Figure 4. Changes in declared agricultural fields and area in Lithuania, 2015–2024. Panel (a) shows the change in the number of declared fields (in thousands) over the period 2015–2024. Panel (b) shows the change in the total declared area (in hectares ×10,000) for the same period.

The change in declared land areas (Fig. 4 (b)) is insignificant, but an increase can be observed in 2020. It is likely that the area declared in 2015 was smaller due to the introduction of a new declaration system, which may have resulted in not all farmers submitting data on their farming areas. Meanwhile, the increase in declared areas recorded in 2020 may be linked to various factors, including the impact of the COVID-19 pandemic on the agricultural sector. However, it is not appropriate to state unequivocally that the pandemic was the main reason for this change – it was most likely one of many factors that influenced agricultural activity.

In addition, changes in support policies, such as stricter requirements or reduced payments, may also have contributed to the change in declared areas. Farmers who did not meet the new criteria may have decided not to declare their land. It is also important to note that the constantly updated database and stricter monitoring of control plots contribute to more accurate accounting of agricultural land. This means that previously unaccounted land areas can be included in the official accounts, while those that do not meet the requirements can be removed from the lists of declared land.

CONCLUSIONS

• Nowadays, agriculture is difficult to imagine without advanced technologies, one of which is GIS. This technology provides farmers with powerful tools that enable them to perform detailed spatial analysis, manage risk, monitor the environment, and make informed decisions. GIS, integrated with other technologies such as remote sensing, unmanned aerial vehicle systems, and big data analysis, opens even broader possibilities. This combination is becoming an integral part of sustainable and efficient agricultural practices.

• Despite its relatively modest contribution to the EU's GDP, estimated at approximately 1.3%, the significance of agriculture in this context extends far beyond this quantitative assessment. The sector's importance is underscored by its role in ensuring food security, sustaining rural communities, and fostering related industries. The processes of industrialization and urbanization have profoundly impacted the agricultural sector, resulting in significant advancements in productivity and enhanced efficiency in land use. However, these developments have concurrently led to a decline in employment opportunities and agricultural output. This dual impact underscores agriculture's pivotal role in promoting sustainable economic, social, and environmental development.

• The study confirmed that urban development processes have a direct and measurable impact on agricultural land use. An analysis of urbanization processes in the ArcGIS Pro environment revealed that the most significant urbanization changes are occurring in the cities of Vilnius, Kaunas, and Klaipėda and their suburbs. It was noted that urbanization is occurring in a scattered manner, often with limited urban planning intervention, which may lead to unbalanced territorial development. To achieve sustainable urban growth and efficient land use, it is necessary to further improve urban planning strategies and coordinate urban development with the preservation of agricultural and natural areas. GIS-based spatial and statistical analysis revealed a gradual reduction in agricultural land areas and an increase in built-up territory over the past decade. This trend reflects the continuous expansion of cities and infrastructure, driven by population growth and changing socioeconomic needs.

• Land Fund data indicate an additional 1.5% reduction between 2015 and 2024, when agricultural land accounted for only 51.64% of the national territory. This decline is primarily driven by urban expansion, infrastructure development, and afforestation, but it is also influenced by natural processes and climate change. The consequences of this trend include rising food prices, reduced employment opportunities in rural regions, increased reliance on imports, and negative impacts on ecosystems and biodiversity. Nevertheless, projections suggest that stricter land-use policies, agricultural intensification, and state support may help stabilize the agricultural land balance in the future.

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