The Development in the Area of the Anthropogenic Landscape and Its Components in Klaipėda County

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Abstract

In recent decades, with the intensification of human activities and accompanying urbanization, research on landscape change, with a focus on the balance between urbanized and natural areas, has become increasingly relevant.

The aim of this article is to analyze the anthropogenic landscape of Klaipėda County and its municipalities from 2011 to 2024. In preparing the article, the following research methods were employed: literature review, assessment of the current situation, grouping, comparison, analytical and statistical analysis, logical analysis, and graphical methods.

The analysis showed that the anthropogenic landscape of Klaipėda County increased by 9,782.82 hectares or 38.05 percent. In 2011, the anthropogenic landscape in Klaipėda County accounted for 4.94%, while in 2024, it accounted for 6.80%.

After analyzing the changes in the areas of landscape components in Klaipėda County, it was determined that the area of built-up land increased by 10,704.50 hectares or 79.42% over a 13-year period. During the same period, road areas decreased by 1,340.81 hectares or 13.32%. At the same time, the area of degraded land increased by 419.20 hectares or 19.35%.

The study shows that rapid urbanization is occurring in Klaipėda County, making it essential to implement environmental protection measures to prevent the degradation of the natural landscape and its components.

***Key words**: Landscape change, anthropogenic landscape, components*

Anotacija

Per paskutinius dešimtmečius, intensyvėjant žmogaus veiklai ir urbanizacijai, kraštovaizdžio pokyčių tyrimai, orientuoti į urbanizuotų ir natūralių teritorijų pusiausvyrą, tampa vis aktualesni.

Šio straipsnio tikslas – išanalizuoti Klaipėdos apskrities ir jos savivaldybių antropogeninio kraštovaizdžio plotų 2011–2024 m. kaitą. Straipsniui parengti buvo taikomi šie tyrimo metodai: literatūros apžvalga, esamos situacijos įvertinimas, grupavimas, palyginimas, analitinė ir statistinė analizė, loginė analizė ir grafikos metodai.

Analizė parodė, kad Klaipėdos apskrities antropogeninis kraštovaizdis padidėjo 9782,82 ha, t. y. 38,05 procento. 2011 metais antropogeninis kraštovaizdis Klaipėdos apskrityje sudarė 4,94 %, o 2024 metais – 6,80 %.

Išanalizavus kraštovaizdžio komponentų teritorijų pokyčius Klaipėdos apskrityje, nustatyta, kad užstatytų teritorijų plotas per 13 metų padidėjo 10704,50 hektaro arba 79,42 %. Tuo pačiu laikotarpiu kelių plotas sumažėjo 1340,81 ha arba 13,32 %, o pažeistos žemės plotas padidėjo 419,20 ha arba 19,35 %.

Tyrimas rodo, kad Klaipėdos apskrityje vyksta spartus urbanizacijos procesas, todėl būtina įgyvendinti aplinkos apsaugos priemones, kad būtų išvengta natūralaus kraštovaizdžio ir jo komponentų degradacijos.

***Reikšminiai žodžiai**: kraštovaizdžio kaita, antropogeninis kraštovaizdis, komponentai.*

Introduction

Humans continually alter their environments, both intentionally and unintentionally, strengthening the link between human activity and anthropogenic landscapes. The study of urbanism and human-made landscapes has a long history in archaeology. Urbanism dates back approximately 6,000 years, whereas anthropogenic landscapes have a much longer history, originating early in human development and becoming more prominent around 10,000 years ago during the Neolithic Revolution (Chase, A. F., Chase, D. Z., 2016).

Humans have transformed the environment by causing disturbances, building physical structures, and introducing external resources (Fleming, Bateman, 2018).

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Anthropogenic activities profoundly reshape landscapes, often surpassing the impact of natural exogenic processes. Activities such as quarrying, fossil fuel extraction, urban development, agricultural land modification, and the construction of large dams provide considerable economic benefits but often lead to significant landscape degradation and damage to protected areas. In some instances, these transformations entirely remodel the terrain, erasing any traces of prior landforms. Additionally, such activities can induce atypical processes in certain regions, such as landslides and land subsidence, which may further threaten cultural heritage sites (Kubalikova, Kirchner, *et al*., 2019).

Anthropogenic landscape changes significantly impact biodiversity and wildlife populations worldwide. However, these changes manifest in diverse ways, and their effects on wildlife vary depending on the context and scale of the landscape. Consequently, studies examining the effects of anthropogenic landscape change on wildlife must account for specific landscape contexts and model these impacts across multiple scales (Emmet, Stodola, *et al*., 2023).

Anthropogenic changes can profoundly impact wildlife populations, often with dramatic consequences. Additionally, by facilitating the spread of vector-borne diseases in various ecosystems, these changes can contribute to the local extinction of native wildlife (Filion, A., Deschamps, *et al*., 2022). Changes in land and sea use have been the leading direct cause of recent biodiversity loss globally. The direct exploitation of natural resources is the second most significant driver, followed by pollution, while climate change and invasive alien species have had comparatively less impact. Since human well-being depends on ecological systems and the benefits they provide, the effects of anthropogenic activities on nature are an increasingly pressing issue for scientific research, political agendas, and public awareness (Jaureguiberry, Titeux, *et al*., 2022).

Efficiently optimizing land resources is crucial for nature conservation, especially in the context of spatial planning in rapidly urbanizing areas. The rapid growth of urbanization and population has significantly stressed the natural environment, with intensified agriculture and the expansion of housing, transportation systems, and industries serving as primary contributors to habitat loss and degradation (Hou, Zhai, *et al*., 2019). Anthropogenic impacts have led to a reduction in natural areas while simultaneously increasing the coverage of anthropogenic landscapes (Wang, Li, *et al*., 2021).

Environmental degradation caused by human land use is often viewed as a problem of the modern industrial age. However, research indicates significant land degradation and a reduction in soil fertility in some regions throughout history (Mueller, R., Borejsza, *et al*., 2013). Land use change is a significant environmental issue. In recent decades, various studies have highlighted the importance of a less visible but equally harmful process: the increasing fragmentation of anthropogenic landscapes (Romanillos, Robazza, 2023).

Various bioindicator techniques are highly effective for detecting and evaluating landscape changes. These methods are typically classified according to criteria such as landscape features, the structure of the test area, and the time frame for the studies. To address the escalating environmental crisis, substantial changes must be made in humanity's relationship with nature. Key priorities include aligning human thought and behavior with environmental sustainability, transforming material production in line with ecological principles, and incorporating ecological concepts into landscape management, particularly through landscape planning (Bastian, Bernhardt, 1993).

A key question in conservation management is how evolutionary, ecological, and anthropogenic processes influence current patterns of ecosystem connectivity. Contemporary ecosystem connectivity results from the interaction between natural barriers—formed by unaltered landscape features, some of which have developed over geological timescales—and landscape features created by anthropogenic disturbance (Wenner, Murphy, *et al*., 2022).

The arrangement of artificial structures (such as buildings, roads, railways, and canals) is consistently influenced by the surrounding topography. In areas of intense human activity,

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particularly urban-industrial or urban-technical ecosystems, patches of semi-natural habitats are rarely found and are typically confined to small spaces within built-up zones or alongside linear infrastructure. Natural micro- and meso-scale topographic features are frequently obliterated by land modifications, such as grading for construction. By integrating principles of anthropogenic geomorphology, landscape ecology can provide valuable insights and practical solutions for landscape planning (Csorba, 2010).

The design and optimization of anthropogenic landscape structures are largely influenced by the extent of human-induced changes within the landscape. This extent is shaped by the ecological potential of the natural system, along with the type and intensity of human impact (Batrachenko, Brazhnik, *et al*., 2024). The development of anthropogenic landscapes often leads to environmental degradation, including habitat destruction, pollution, and biodiversity loss. It can overexploit natural resources, disrupt ecosystems, and contribute to climate change. Social issues such as displacement, inequalities, and overcrowding may arise, along with aesthetic and cultural losses. Additionally, poorly planned development increases disaster risks and economic costs while reducing agricultural land. Balancing development with sustainability is crucial to mitigating these challenges.

This article focuses on the anthropogenic landscape and its components in Klaipėda County.

Its objective is to analyze the changes and dynamics of the anthropogenic landscape and its components in the Klaipėda County over the period from 2011 to 2024.

Research Methodology

- This study employed a range of theoretical and practical research methods to achieve its objectives. The theoretical section was developed based on scientific publications and existing research. The introduction presents an analysis of scientific literature examining the impact of human activities and changes in the anthropogenic landscape on biodiversity and the environment. It also highlights the importance of optimizing land resource use for conservation, particularly in rapidly urbanizing regions.
- A comparative method was used to evaluate changes in the anthropogenic landscape and its components in Klaipėda County and its municipalities between 2011 and 2024. The resulting changes are detailed in both hectares and percentages, providing a comprehensive overview of land use transformations. This data, derived from the Land Fund of the Republic of Lithuania (Nacionalinė..., 2011–2024), serves as a reliable source for tracking and measuring shifts in land distribution over time.
- Presenting the changes in both hectares and percentages allows for a clearer understanding of the scale and impact of these transformations within Klaipėda County and its municipalities. The dual format highlights not only absolute changes in land area but also their relative significance in the overall landscape.
- Analytical and logical analysis methods were applied to identify the factors contributing to changes in anthropogenic landscape areas. By incorporating both approaches, the study provides a deeper understanding of how urbanization, infrastructure development, and environmental policies have influenced landscape transformations.
- To enhance the depth of the study, graphical methods were also utilized. Graphical representations simplify data presentation and add a visual dimension to the analysis, making it easier to depict and comprehend key trends.

The Results of the Study and Their Discussion

The Current State of the Anthropogenic Landscape and Its Components. Anthropogenic landscapes, rather than being opposed to natural landscapes, are recognized as a distinct genetic category of landscapes that originate from human interference yet continue to follow natural laws of development. The science of anthropogenic landscapes examines the physical-geographic and

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ecological aspects of human impact on the environment, while land-use studies focus on the technological and economic implications of such impact.

An anthropogenic landscape is a landscape significantly altered or created by human activity. This includes areas where natural landscapes have been modified for purposes such as urbanization, industry, transportation, and infrastructure development. Examples include cities, roads, and industrial zones, which reflect human influence by altering natural topography, vegetation, and ecosystems in various ways. Thus, the anthropogenic landscape consists of key components such as roads, built-up areas, and degraded land.

According to 2024 data (Nacionalinė…, 2024), the anthropogenic landscape in Klaipėda County covered 35,496.13 hectares, or 6.80% of the county's total area.

For comparison, the total anthropogenic landscape in Lithuania in 2024 covered 378,935.74 hectares, constituting 5.80% of the country's total territory. This indicates that Klaipėda County has a slightly higher percentage of anthropogenic land use than the national average, reflecting the impact of urbanization, industrial development, and other human activities in the region.

The analysis of Klaipėda County's municipalities in 2024 reveals significant variation in land use across the region:

Klaipėda Municipality has the largest anthropogenic landscape, covering 3,875.78 hectares (39.57% of the municipality's total area), reflecting the highly urbanized and industrial nature of Klaipėda city.

Klaipėda District follows with 11,342.83 hectares (8.57%), indicating substantial human impact, particularly in suburban and industrial zones surrounding the city.

Palanga Municipality has an anthropogenic landscape of 1,596.90 hectares (20.19%), reflecting its role as a major tourist destination and resort.

Kretinga District covers 5,843.78 hectares (5.91%), with human activity more evenly distributed compared to other districts.

Šilutė District has 8,314.18 hectares (4.94%), indicating significant land use for agriculture and development.

Neringa Municipality has the smallest anthropogenic landscape, with only 325.05 hectares (2.34%), consistent with its more preserved natural environment.

Skuodas District shows 4,197.61 hectares (4.61%), reflecting moderate anthropogenic changes.

These variations demonstrate the diverse impact of human activities across Klaipėda County. Urban and tourism centers such as Klaipėda and Palanga have significantly higher concentrations of anthropogenic landscapes, while areas like Neringa remain more preserved.

Table 1. The anthropogenic landscape areas in hectares and percentages in the municipalities of Klaipėda County in 2024

1 lentelė. *Klaipėdos apskrities savivaldybių antropogeninio kraštovaizdžio plotai hektarais ir procentais, 2024 m.*

Municipalities of Klaipeda County	The area of the anthropogenic landscape in ha	The area of the anthropogenic landscape in percent
Klaipeda	3,875.78	39.57
Klaipeda district	11,342.83	8.57
Kretinga district	5,843.78	5.91
Neringa	325.05	2.34
Palanga	1,596.90	20.19
Silute district	8,314.18	4.94
Skuodas district	4,197.61	4.61

Source: compiled by the authors (Nacionaline…, 2024)

Šaltinis: sudaryta autorių (Nacionaline…, 2024)

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Changes in the Anthropogenic Landscape Area in Klaipėda County (2011–2024). In 2011, the anthropogenic landscape in Klaipėda County covered 25,713.24 hectares. By 2024, this area had increased by 9,782.89 hectares, representing a 38.05% expansion (Figure 1).

A detailed analysis of the data in Figure 1 reveals significant transformations in the components of the anthropogenic landscape during this period.

Built-up areas experienced a substantial increase of 10,704.50 hectares (79.42% growth), indicating intensified urban and industrial development. This reflects rising human activity and infrastructure expansion in the region.

Damaged land increased by 419.20 hectares (19.35% growth), primarily due to the expansion of mineral extraction sites and the establishment of new quarries.

Road areas saw a notable decrease of 1,340.81 hectares (13.32% reduction). This decline is largely attributed to discrepancies in theoretical calculations before 2015 and the introduction of cadastral measurements that began that year. Since 2015, road area data have been updated annually, making earlier figures less precise. As a result, the decrease in road areas is considered a methodological correction rather than an actual reduction in infrastructure.

These trends highlight the dynamic evolution of Klaipėda County's anthropogenic landscape, with significant implications for land use, environmental quality, and sustainable development. While these changes present economic growth opportunities, they also pose environmental challenges, including habitat loss, increased pollution, and resource depletion.

To address these challenges, sustainable development practices should be prioritized, ensuring that urban expansion is balanced with environmental conservation and the well-being of local communities. Future research on land-use policies, environmental regulations, and urban planning strategies will be essential to managing growth responsibly and sustainably.

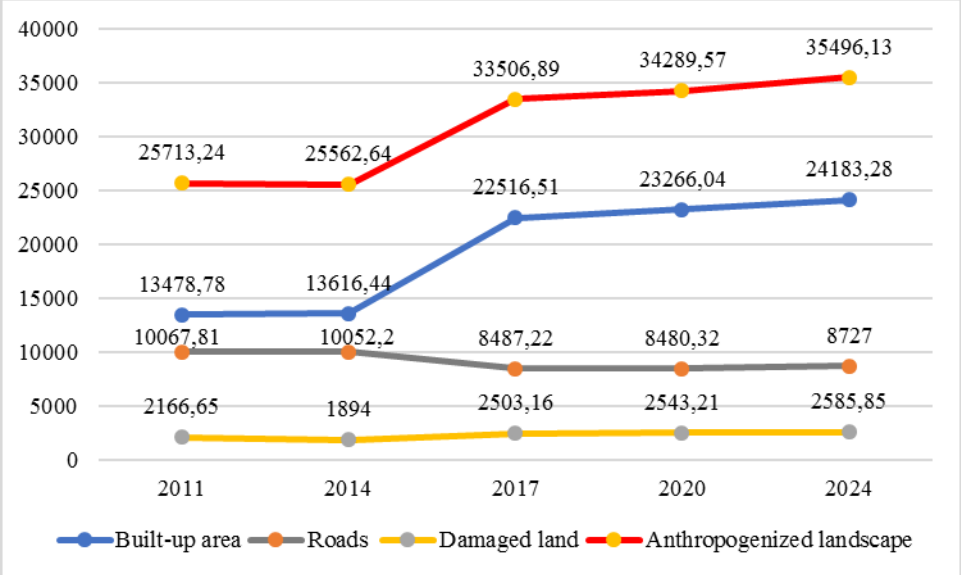

Fig. 1. The change in the anthropogenic landscape and its components in Klaipėda County from 2011 to 2024, expressed in hectares

1 pav. *Klaipėdos apskrities antropogeninio kraštovaizdžio ir jo komponentų plotų kaita hektarais nuo 2011 iki 2024 metų*

Source: compiled by the authors (Nacionaline…, 2011–2024)

Šaltinis: sudaryta autorių (Nacionaline…, 2011–2024)

The study of changes in the anthropogenic landscape between 2011 and 2024 in the municipalities of Klaipėda County reveals a significant increase in the area of anthropogenic landscapes across all municipalities. This trend highlights the ongoing urbanization and human impact on the environment. The most substantial growth in anthropogenic landscape area was

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observed in the Klaipėda district, which saw an expansion of 5,139.78 hectares, representing an increase of 82.86%. Similarly, the city of Klaipėda experienced notable growth, with an increase of 1,288.76 hectares, or 49.82% (Table 2).

In contrast, the Skuodas district exhibited the smallest expansion of anthropogenic landscapes. Over the period from 2011 to 2024, the area increased by only 87.33 hectares, or 2.13%.

This data underscores the varying rates of development across Klaipėda County, with some areas experiencing significant urban growth, while others maintain more stable or controlled landscape changes. The results of this study provide valuable insights into the trends of anthropogenic landscape development and could serve as a foundation for future urban planning and environmental management strategies in the region.

Table 2. The changes in the anthropogenic landscape area, measured in both hectares and percentages, across the municipalities of Klaipėda County from 2011 to 2024

2 lentelė. *Klaipėdos apskrities savivaldybių antropogeninio kraštovaizdžio kaita savivaldybėse 2011-2024 m., hektarais ir procentais*

Municipalities of Klaipeda county	The change in the anthropogenic landscape in hectares	The change in the anthropogenic landscape in percent
Klaipeda	**+ 1,288.76**	**+ 49.82**
Klaipeda district	**+ 5,139,78**	**+ 82.86**
Kretinga district	**+ 966.18**	**+ 19.81**
Neringa	**+ 105.63**	**+ 48.14**
Palanga	**+ 299.24**	**+ 23.06**
Silute district	**+ 1,895.92**	**+ 29.54**
Skuodas district	**+ 87.38**	**+ 2.13**

Source: compiled by the authors (Nacionaline…, 2011–2024)

Šaltinis: sudaryta autorių (Nacionaline…, 2011–2024)

Several factors contribute to changes in anthropogenic landscape areas, which involve human interventions in natural landscapes. These changes are driven by various socio-economic, environmental, and technological forces:

1. The expansion of anthropogenic landscape often leads to the transformation of natural landscapes into urban environments. This includes the development of housing, infrastructure, roads, and commercial areas. Population growth and migration from rural to urban areas accelerate urban sprawl, increasing the extent of anthropogenic landscapes.
2. Large-scale infrastructure projects, such as the construction of roads, railways, airports, dams, and communication networks, significantly impact the natural landscape. These projects often fragment ecosystems, change hydrological patterns, and lead to habitat loss or degradation.
3. Innovations in transportation, communication, and energy infrastructure can create new urban and industrial zones.
4. Economic Development and Globalization Economic growth and the globalization of trade often result in the expansion of infrastructure, urban areas, and industrial sites, increasing the size of anthropogenic landscapes.
5. Landfills and mineral extraction quarries also contribute to the development of anthropogenic landscapes and can cause various environmental issues. Landfills and mineral extraction quarries have a significant impact on the landscape and the environment. These human-made and often irreversible changes can significantly alter both the physical and ecological surroundings.

Regulating the development of anthropogenic landscapes is essential for balancing urban growth, environmental preservation, and sustainable land use. Proper regulation can mitigate

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negative impacts on ecosystems, biodiversity, and natural resources while fostering controlled urbanization.

It is necessary to regularly monitor the development of the anthropogenic landscape using satellite imagery, drones, or direct and statistical data assessments. This would allow monitoring and evaluating land use changes.

It is also very important to integrate climate change regulation challenges into the territorial planning of Klaipėda County, ensuring that development is resilient to changing environmental conditions such as rising sea levels, extreme weather events, and temperature fluctuations.

It would be significant to strengthen environmental protection laws and regulations at the local, regional, and national levels to ensure that the growth of anthropogenic landscape areas aligns with the principles of sustainable development.

It is important to create policies that align with long-term sustainability goals, ensuring that development does not harm future generations and the environment.

Conclusions

1. In 2024, the anthropogenic landscape in Klaipėda County covered 35,496.13 hectares, accounting for 6.80% of the county's total area. Klaipėda municipality had the largest anthropogenic landscape, spanning 3,875.78 hectares (39.57% of its total area). In contrast, Neringa had the smallest anthropogenic landscape, with just 325.05 hectares, or 2.34% of its area, reflecting its largely preserved natural environment.
2. In 2011, the anthropogenic landscape in Klaipėda County covered 25,713.24 hectares. Between 2011 and 2024, the area increased by 9,782.89 hectares, representing a growth of 38.05%.
3. Between 2011 and 2024, significant shifts occurred in the components of the anthropogenic landscape. Built-up areas expanded dramatically by 10,704.50 hectares, a 79.42% increase. Damaged land also grew by 419.20 hectares, reflecting a rise of 19.35%. Conversely, road areas decreased by 1,340.81 hectares, or 13.32% However, this decrease is considered conditional due to changes in data measurement methodology.
4. All municipalities in Klaipėda County experienced an increase in anthropogenic landscapes between 2011 and 2024. The Klaipėda district recorded the largest expansion, adding 5,139.78 hectares (82.86% growth). Similarly, Klaipėda city saw a notable increase of 1,288.76 hectares (49.82%). Skuodas district experienced the smallest growth, with an increase of only 87.33 hectares (2.13%).
5. Sustainable development of anthropogenic landscapes requires a proactive approach, including regular monitoring of land use changes, integrating climate resilience into territorial planning, and strengthening environmental regulations. By aligning policies with long-term sustainability goals, it is possible to balance development needs with environmental preservation, ensuring a harmonious future for both the environment and future generations.

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Antropogeninio kraštovaizdžio ploto ir jo komponentų plėtra Klaipėdos apskrityje

(Gauta 2025 m. sausio mėn.; atiduota spaudai 2025 m.vasario mėn.; prieiga internete nuo 2025 m. gegužės 9 d.)

Santrauka

Šio straipsnio objektas – Klaipėdos apskrities atropogeninis kraštovaizdis.

Straipsnio tikslas – išanalizuoti Klaipėdos apskrities ir jos savivaldybių antropogeninio kraštovaizdžio 2011–2024 m. plotų kaitą.

Straipsnyje pateikiama 2011–2024 m. antropogeninio kraštovaizdžio plotų kaitos lyginamoji analizė. Nagrinėjama plotų kaita hektarais ir procentais tiek Klaipėdos apskrityje, tiek joje esančiose savivaldybėse.

2024 m. antropogeninis kraštovaizdis Klaipėdos apskrityje užėmė 35496,13 hektarų, sudarydamas 6,80 % viso apskrities ploto. Didžiausias antropogeninio kraštovaizdžio plotas nustatytas Klaipėdos savivaldybėje, jo plotas siekė 3875,78 ha arba 39,57 % savivaldybės bendro ploto. Mažiausias antropogeninio kraštovaizdžio plotas nustatytas Neringoje – 325,05 ha arba 2,34 %.

2011 m. Klaipėdos apskrities antropogeninis kraštovaizdis užėmė 25713,24 hektarų. Nuo 2011 m. iki 2024 m. šis plotas padidėjo 9782,89 ha arba 38,05 %.

2011–2024 m. laikotarpiu įvyko reikšmingų antropogeninio kraštovaizdžio komponentų pokyčių: užstatytos teritorijos išaugo 10704,50 ha arba 79,42 %, pažeistos žemės plotas taip pat padidėjo 419,20 ha arba 19,35 %, kelių plotas sumažėjo 1340,81 ha arba13,32 %, tačiau šis sumažėjimas laikomas sąlyginiu.

2011–2024 m. laikotarpiu visose Klaipėdos apskrities savivaldybėse antropogeninio kraštovaizdžio plotas didėjo. Didžiausia antropogeninio kraštovaizdžio plėtra vyko Klaipėdos rajono (5139,78 ha arba 82,86 %) bei Klaipėdos miesto (1288,76 ha arba 49,82 %) savivaldybėse. Mažiausias analizuojamo ploto augimas nustatytas Skuodo rajone, jame antropogeninio kraštovaizdžio plotas padidėjo 87,33 ha arba 2,13 %.

Tvariam antropogeninio kraštovaizdžio vystymui būtinas aktyvus požiūris, apimantis reguliarius žemės naudojimo pokyčių stebėjimus, klimato kaitos prevencinių priemonių integravimą į teritorijų planavimą ir aplinkosauginių reguliavimų stiprinimą.

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