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AN ANALYSIS OF URBAN GREEN SPACES – A CASE STUDY IN POLAND AND SLOVAKIA

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ABSTRACT

Motives: Rapid urbanisation and the associated spatial, environmental, and economic changes have shifted the researchers' attention to modern cities. Urban green spaces are a vital component of sustainable development because they reduce noise, purify air, improve the local climate and rainwater quality, and provide numerous recreational and relaxation opportunities for the residents. The implementation of the green city concept can have a positive impact on both the environment and the quality of life in a city.
Aim: The aim of the study was to analyse changes in the landscape and surface of urban green spaces, to present the structure of green areas, and to identify change trends in urban green spaces in the Polish city of Toruń and the Slovak city of Košice. The ecological resilience of the studied areas was also examined.
Results: The results of the study indicate that the area occupied by urban green spaces (including urban green areas, sport and leisure facilities, and forests) continues to expand in the studied cities. The rate of increase was much higher, but still low, in the Slovak city of Košice. The analysis of change trends revealed that most industrial and commercial areas were developed in urban green spaces. At the same time, new green spaces were created mainly at the expense of semi-natural areas. Both Toruń and Košice are characterised by average landscape stability.

Keywords: 2030 Agenda, sustainable urban development, green city, landscape management, resilience

INTRODUCTION

By the middle of the century, up to 70% of the world's population will live in urban areas (UN-Habitat, 2022). Urbanisation and climate change require new solutions to maintain and, above all, improve the quality of life in our cities. Cities and towns are beginning to realise the dangers of climate change (Čepelová & Douša, 2018). Green areas of the city are an inseparable element of a sustainable and smart city. In the era of intensifying climate crises, green areas are one of the elements shaping urban

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resilience and ecological stability (Costanza, 1997; Meerow et al., 2016). The analysis and assessment of ecological stability, which is a fundamental component of the idea of urban environmental sustainability, is the foundation for the planning process of urban development (Yukhnovskyi & Zibtseva, 2019). Today, cities occupy less than 3% of the Earth's surface (United Nations, 2018). They are not only engines of growth of a socio-economic nature, but also the site of dynamic environmental transformations. Global sustainability is largely determined by cities, whose current unstable trajectory in terms of urban ecosystems and landscapes requires a focus on ecology and the environment (Wu, 2014). Urbanisation tends to reduce the ratio of land allocated to public green spaces (Noszczyk et al., 2022). However, in the face of contemporary challenges, concern for the environment is an integral part of moving towards sustainable development.

Green spaces are an integral component of the urban landscape and a foundation for the pursuit of sustainable development (Darkwah & Cobbinah, 2014; Łachowski & Łęczek, 2020). They are also an important aspect of adapting to ongoing climate change, building social cohesion and developing the green economy (Hansen et al., 2017). Especially in highly urbanised areas, they are an important component of the urban space and improve it in terms of aesthetics (Szczepańska et al., 2016). Green infrastructure in cities provides maximum ecosystem benefits hence its development is highly desirable nowadays (Augustyn, 2020). In the literature, one can find many studies and documents on the urban green ecosystem and its benefits to the well-being of society (Anguluri & Narayanan, 2017). Thus, greenery in the city also has a leisure and health function as it provides space for relaxation thus enhancing the quality of leisure activities. Prominent exposure to greenery also benefits the psychological well-being of the public (Wang et al., 2019). Just looking at areas of urban greenery creates a sense of relaxation and, as a result, can have a positive impact on stress reduction processes (Elsadek et al., 2020). Studies based on European cities show that by increasing the amount of green areas it is possible to reduce premature deaths and they also have a positive impact on the transformation of cities towards more sustainable and good to live in centres (Barboza et al., 2021). Urban green spaces, complemented by infrastructure in the form of footpaths and bicycle lanes, also provide a place for recreational activities, the positive and important importance of which was particularly recognised during the pandemic (Venter et al., 2021). Studies show that during the pandemic, forests played an important social role in terms of both mental and physical health (Derks et al., 2020). Urban vegetation is also an effective method to promote the reduction of heat intensity (Marando et al., 2022). Applied on a large scale, green spaces, e.g. forests, can have a positive impact on thermal comfort and reduce the urban heat island effect by shaping the shade-induced cooling effect (Virtudes, 2016; Rogatka et al., 2018). Tree crowns create shade, which, together with evapotranspiration, reduces temparature and thus contributes to the thermal comfort of residents (Sun et al., 2021). In addition, green spaces minimise the risk of flooding within the city by reducing surface runoff (Chiabai, 2020). Moreover, greenery in the city located in appropriate places can reduce the negative impact of pollution by creating a natural biological filter that neutralises harmful components from the air (Daniele & Sciacca, 2021; Gubański et al., 2018).

Urban green spaces play an important role in the creation of urban space and the process of reducing the negative effects of urbanization, by maintaining a balance between transportation infrastructure, buildings and green spaces (Harasimowicz, 2018).

According to research by Čepelová and Douša (2018, 2020), many urban areas are already suffering from the negative effects of climate change and other negative consequences. The effects of climate change on urban living conditions will continue to be dramatic, due to rising temperatures, more frequent rains with consequent floods or, conversely, excessive drought. The most successful cities plan to combine the implementation of action plans and investments. However, stand-alone action plans and investments often fail to take full advantage of the synergies

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between optimal coordination and co-ordination of interrelated strategies, subsequent investments and the involvement of urban dwellers. Strong institutional structures and sound financial mechanisms are needed for cities to pursue their green agendas effectively. Both the surveyed cities in both Poland and Slovakia don't have a comprehensive climate strategy to protect the environment and support green spaces. Cities and municipalities are often blocked from implementing measures due to limited political power, low levels of institutional capacity, low levels of stakeholder cooperation, limited fiscal power, poor financial management and insufficient access to finance. Cities need a strong institutional environment that allows their municipalities to operate more efficiently, flexibly and competitively in order to achieve the ambitious green city agenda.

GREEN CITIES – A THEORETICAL APPROACH

Sustainable development has been the subject of much academic debate since the 1960s. Over the following years, many studies have been written on this issue. For the first time the concept was defined in 1987 in the report 'Our Common Future' as 'development that meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED, 1987). The issue is described by, among others: Agenda 21 (1992), the Rio Declaration on Environment and Development (1992), the Eight Millennium Goals (2000) and Agenda 2030, which consists of 17 Sustainable Development Goals (UN, 2015). This article focuses on green urban areas (GUAs), which have a direct impact on the three goals (Siragusa et al., 2020): SDG 11 Sustainable cities and communities; SDG 13 Climate action; SDG 15 Living on land.

Sustainable development should not only be considered at the global level, but above all at the local level (Trovato, 2021), which is particularly influenced by GUAs. This is because cities are characterised by having features that intensify the consequences of climate change and extreme weather events (ESPON, 2020). In a post-indurstial world, there has been a shift in the function of cities from industrial to business, innovation or finance, and contemporary cities are both concentrators of global problems and drivers for their solutions (Niemets et al., 2021). One way to support sustainable practices is to provide access to green spaces. Hence, an opportunity to transform cities towards greater sustainability is the concept of green cities. A green city can be defined as „a city that promotes energy efficiency and renewable energy in all its activities, widely promotes green solutions, uses compactness of land with mixed land use and social mixing practices in its planning systems, and anchors its local development in the principles of green growth and equity" (Brilhante & Klaas, 2018). Ecological stability is also an important element of sustainability. It can be defined as the ability of an ecosystem to resist change during disturbances, which is characterised by low variability, i.e. low deviation from the mean level despite changing environmental conditions.

Ecological stability is important in terms of the carrying capacity of the environment. In order for a landscape to withstand greater or lesser changes (stress, strain, etc.), it must achieve certain levels of ecological stability. The ecological stability of the area can be considered directly as one of the key principles of (environmental) sustainability (National Network of Healthy Cities CR, 2022). The landscape is made up of a set of components (=areas) that put together a landscape matrix. The components can be divided into stabilizing and labile. If any activity is carried out in the landscape that could affect the landscape character or functionality of any of its components or the character of the landscape, it is necessary to be able to evaluate the positive or negative consequences. It is an objectification of the definition of the dynamics of the landscape system = the exact numerical expression of changes in the landscape.

The coefficient of ecological stability (CES) represents a ratio number (coefficient), which determines the ratio of so-called stable and unstable areas of landscape-forming elements in the monitored area (Míchal, 1994). In addition, ecological stability is the

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ability of an ecological system to persist even under the influence of a disturbing influence and reproduce its characteristics in the conditions of disturbance from the outside (especially disturbance by humans). CES this expresses how a certain territory can cope with these influences (Kolejka, 2011).

The aim of this article is to analyze changes in the landscape and surface of green areas, to present the structure of green areas and to indicate the directions of transformations in the studied city in Poland and Slovakia.

MATERIALS AND METHODS

Spatial scope of the research

Two European cities – Toruń in Poland and Košice in Slovakia – were used as testing grounds for the comparative study. The authors chose these two cities because of their similar size and population. Toruń is a provincial city with almost 200,000 inhabitants with an area of 115.72 km². Košice is inhabited by nearly 240,000 people – 243.73 km² area. In addition, both cities are regional capitals (in Poland the Kujawsko-Pomorskie Voivodship, in Košice the Košice Country) and thus play the role of a central centre according to Christaller's assumptions. In addition, the article examines green areas, and their nature depends on the climatic conditions. Both cities lie in the same climatic zone, so the structure of green areas in Toruń and Košice will not be detrimental to zonal factors, and comparative analyzes will be possible. However, the overriding criterion for selecting the cities for analysis was their post-industrial character. In the era of global industrialisation, in the space of both cities one could see thriving industrial units, which due to their space-intensive nature intensively consumed green areas.

According to Kocan (2020), the urban landscape, being a dynamic structure, is the most susceptible to all kinds of changes, both at the social and spatial level. In both analysed cities the industry was very active. It was an important part of the economic structure of Toruń and Košice. In Toruń, there was the chemical plant „Polchem", which generated pollution affecting both ecological stability and the condition of green areas. In the case of Košice, the industrial history of the city is still relevant. The largest Slovak steelworks is located in the city – that is why Košice is called „the steel heart of Slovakia".

Research structure, data and methodology

The study was divided into three main stages, i.e. the introductory stage (I); the implementation stage (II) and the concluding stage (III). The introductory stage included an analysis of the literature on urban green areas and European strategic documents such as Agenda 2030, which focuses on sustainable development, with particular emphasis on the role of green areas and ecological stability. The introductory stage ended with defining the purpose and delimitation of the study area. The core of the study, which filled out the entire executive stage, was two research methods:

1. Spatial analyses using GIS;
2. Coefficient of ecological stability (CES).

As a result of the constantly increasing rates of urbanization and construction in both analyzed cities, these two cities were chosen for evaluation. More than 80% of the European population is expected to live in urban areas by 2030 (European Healthy Cities Network, 2022). On the basis of normative values based on data on the density of construction and the degree of urbanization to the total number of inhabitants of the investigated cities, we expect negative results of the ecological stability of the territory and the decline of natural ecosystems in the investigated time period.

GIS METHOD

First, the authors prepared a vector data set from the pan-European land cover database Urban Atlas. These data were downloaded for two years, 2006 and 2018, for two cities that were the testing ground. On the basis of the prepared dataset, one category of area called green spaces was synthesised and separated, which in its structure included land cover data for areas classified in the Urban Atlas as: green urban areas, sport and leisure facilities and forest.

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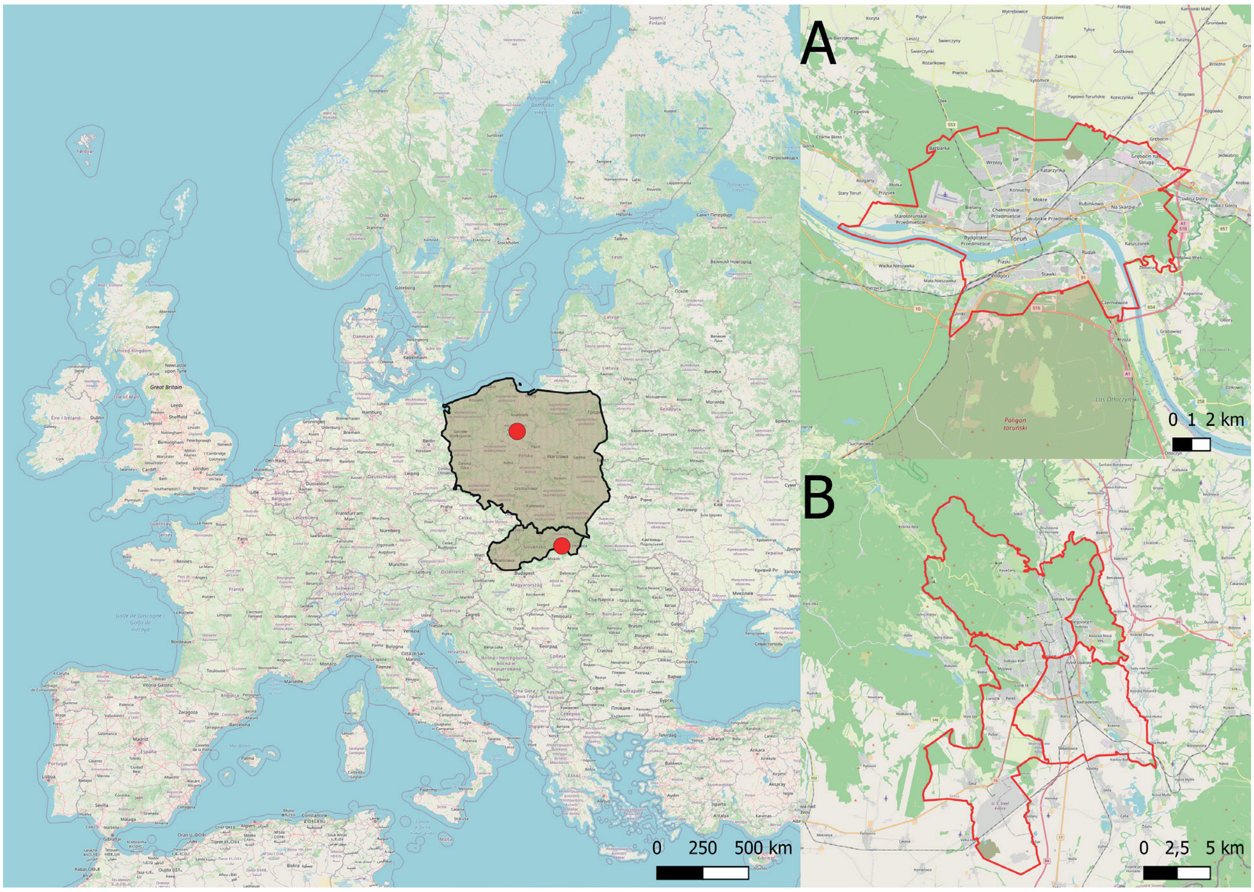

Fig. 1. Spatial scope (A: Toruń; B: Košice)
Source: own preparation.

The prepared vector data were cropped to the borders of the study area, i.e. the administrative borders of Toruń and Košice. In this way, two map compositions were constructed taking into account the coverage of green spaces in Toruń and Košice in the two reference years. Based on these data, the percentage share of green spaces in each city was determined.

In the next step, using geoprocessing tools, an analysis of changes in the area of green spaces in the analysed cities was prepared. In this way, areas which have become green and those which have lost their green character were indicated. Next, on the basis of the prepared map bases, an analysis was made of changes in land cover in selected study plots, i.e. selected urban spaces of Toruń and Košice. The analysis took into account the nature of the change, i.e. in which direction the transformation of green spaces took place. The vector data analysis method was developed and carried out based on the methodology of spatial analyzes with the use of GIS software (Głowacki, 2005).

CES METHOD

Furthermore, qualitative methods were used to fulfil the goal and results, to examine the calculation of the coefficient of the ecological stability of the area according to Míchal (1985) and Miklós (1986). To capture the landscape multifunctionality and to indicate the environmental quality of the area under study, land use provided in parallel by arable land, forests, and bodies of water were studied.

The ratio is determined on the basis of the following elements: Stable elements (WL – woodland;

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WS – water areas and streams; PG – permanent grassland; Pa – pastures; We – wetlands; Or – orchards; Vi – vineyard) and Unstable elements (PL – ploughland; AA – anthropogenic areas; HG – hop-garden). The method of calculating CES is based on a clear and final classification of a landscape element into a group of stable or unstable and does not allow the assessment of the specific state of these elements. The CES value can take the following values and determine the specific ecological resistance:

1. CES ≤ 0.10 areas with maximum disturbance of natural structures, basic ecological functions must be intensively and permanently replaced by technical interventions;
2. 0.10 < CES ≤ 0.30 areas used above average with a clear disruption of natural structures;
3. 0.30 < CES ≤ 1.00 areas intensively used with considerable ecological instability;
4. 1.00 < CES < 3.00 quite balanced landscape in which the technical objects are relatively in accordance with the preserved natural structures;
5. CES ≥ 3.00 natural and nature-friendly landscape (significant predominance of ecologically stable structures) (Míchal, 1985).

At present, there is no longer a purely natural landscape on Earth, because through the changes of the atmosphere, man affects the entire surface of the planet. However, a natural landscape is one whose construction components and processes do not show man-made manifestations.

The tables below contain data on the stable and unstable landscape elements in Košice and Toruń (see Table 1 and Table 2).

The Coefficient of Ecological Stability According to Míchal (1985)

Calculation of CES (in ha) = natural and near-natural areas divided by cultural areas. Specifically, CES = (woodland + water areas and streams + permanent grassland + pastures + wetlands + orchards + vineyard) / (built-up areas + ploughland + hop-garden). The higher the number, the greater the proportion of permanent vegetation areas, the greater the stability of the area (Míchal, 1985). There are many methodologies, but all are based on the same principle. The calculation is always based on the evaluation of the ratio of ecologically stable

Table 1. Stable and unstable elements in the city of Košice district Košice I

Stable elements	Area (in m2)	Unstable elements	Area (in m2)
Woodland	5 154 000	Ploughland	304 000
Water areas (artificial reservoirs, ponds, natural streams)	66 000	Anthropogenic areas (built-up areas)	1 822 000
Permanent grassland	780 000	Hop – garden	not identified
Gardens	391 000		
Researched district area Kosice I. – Džungla, Kavečany, Košice – north, Habitation Ťahanovce, Košice – Old town, City district of Ťahanovce			

Source: The data were obtained from the State Administration of Land Surveying and Cadastre of the Slovak Republic 2022 (The Geodesy, Cartography and Cadastre Authority of the Slovak Republic, 2022).

Table 2. Stable and unstable elements in the city of Toruń

Stable elements	Area (in m2)	Unstable elements	Area (in m2)
Woodland	37 339 335	Ploughland	5 176 207
Water areas (artificial reservoirs, ponds, natural streams)	7 516 318	Anthropogenic areas (built-up areas)	23 824 850
Permanent grassland	28 355 726	Hop-garden	not identified
Gardens	3 593 883		

Source: based on data from The Main Geodesy and Cartography Office (database of topographic objects, DoA: 19.05.2022).

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and ecological labile components of the landscape; individual methodologies differ in the categorization of landscape segments, or in the use of more detailed coefficients.

Miklós ecological stability coefficient (1986)

Unlike the following methodologies, it is not based on the division of areas into stable and unstable, but differentiates their ecological significance by introducing numerical coefficients:

a. pn i – area of individual areas;
b. kpn i – coefficient of ecological significance of areas;
c. p – area of the area of interest (or cadastral);
d. field – 0.14; meadows – 0.62; pasture – 0.68; gardens – 0.5; fruit orchards – 0.3; forests, water, wetlands – 1.00; others – 0.10 (+ lada – 0.62, vineyards – 0.3, rocks – 0.4, line company– 0.4) (Miklós, 1986).

In the last stage of the research – the summary stage, a synthetic analysis of the results of the research was made. This part of the research included mainly the interpretation of changes in the coverage of green spaces in Toruń and Košice and a reference to ecological resilience in both cities.

From the results of the CES of analysed cities in Poland and Slovakia according to the Miklos methodology, they belong into the category of medium stable landscape < 1. Slovak and Poland landscape schools know and use various methodologies. None of them is anchored in the legislation, the closest to the legal norm is the calculation of CES according to Michal, because it is also implemented in the concept of TSES (Territorial systems of ecological stability) = Act No. 114/1992 Coll., § 3 letter a. and landscapes. Because each methodology uses division into different landscape segments and different coefficients, the result may be different, see. result of applied methodologies. Miklós medium stable landscape, Míchal natural and close to nature landscape. However, when planning the use of the landscape and its territory, it is always necessary to pay attention to aspects of sustainable development and try to respect natural structures at the expense of unstable anthropogenic areas.

RESULTS

The results of the research have been aggregated into three thematic blocks:

Block I – analysis of the share of green spaces in general city area
Block II – analysis of directions of green space transformations
Block III – analysis of CES

Block I: analysis of the share of green spaces in general city area

In the base year of 2006, the area of green urban areas in Toruń was 537.84 hectares. In Kosice, on the other hand, green urban areas covered an area of 412.62 hectares. In 2018, both cities saw a decrease in the area of green urban areas, but in the case of Toruń the decrease was much more pronounced. In 2018, green urban areas in Toruń occupied 509.12 hectares. In Kosice, these areas decreased in area by only 2.64 hectares (cf. Table 3).

Another element analysed as part of green spaces was sport and recreation areas. Here, too, both cities

Table 3. Changes in green spaces area

City	GUA 2006 [ha]	GUA 2018 [ha]	Difference GUA 2018–2006 [ha]	SPORT and LEISURE 2006 [ha]	SPORT and LEISURE 2018 [ha]	Difference SPORT and LEISURE 2018–2006 [ha]	FOREST 2006 [ha]	FOREST 2018 [ha]	Difference Forest 2018–2006 [ha]
Toruń	537,84	509,12	-28,72	479,25	466,65	-12,59	3238,27	3380,26	141,99
Košice	412,62	409,98	-2,64	723,53	711,09	-12,44	8130,86	8455,79	324,93

Source: own preparation.

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recorded a decrease in the area of this category of land cover, but in both cities the decrease remained at a similar level, i.e. about 12 hectares.

The only component of green spaces which increased its area was forests. In both of the analysed cities, the area of forest areas increased, noting that in Košice there were more than twice as many forests as in Toruń. All these elements influenced the total share of green spaces in the cities under study.

In 2006, green spaces in Toruń occupied 36.77% of the city area. In Košice, on the other hand, these areas occupied 38.02%. In 2018, the share of green spaces in both cities increased by 0.87% in Toruń and 1.27% in Košice, respectively. This result was mainly influenced by the increase in the area of forests in the cities. Detailed results of changes in the area of green spaces are provided below in tabular form.

Analysing the spatial distribution of changes in the surveyed cities, it should be pointed out that in the case of Košice, these changes were concentrated in the northern and central parts of the city and mostly concerned the creation of new forest areas (Fig. 3). There were no special arrangements and directions in the formation of green spaces. The following figure shows the growth of forests and places where there

Table 4. Green spaces – a comparative approach

City	TOTAL green spaces 2006 [ha]	Share of green areas in the city area 2006	TOTAL green spaces 2018 [ha]	share of green areas in the city area 2018	Percentage difference 2018–2006
Torun	4255,36	36,77%	4356,03	37,64%	0,87%
Košice	9267,01	38,02%	9576,85	39,29%	1,27%

Source: own preparation.

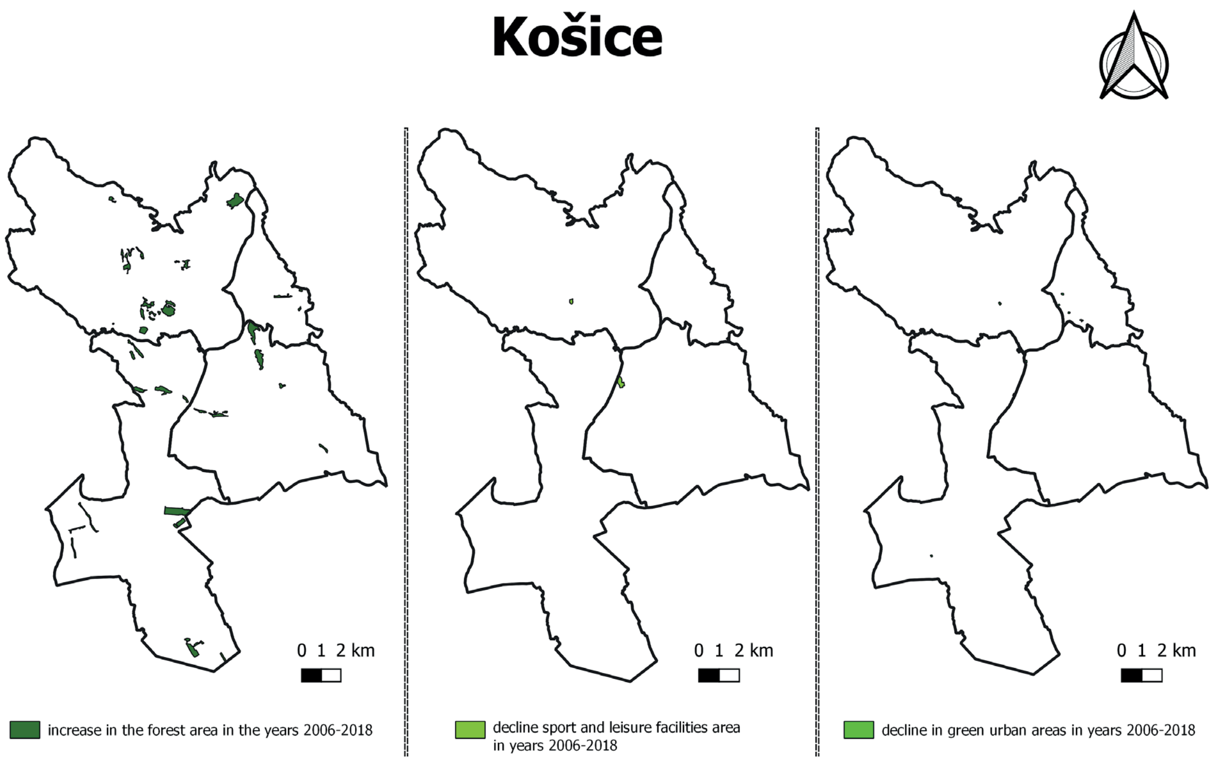

Fig. 2. Changes in green spaces in Košice
Source: own preparation.

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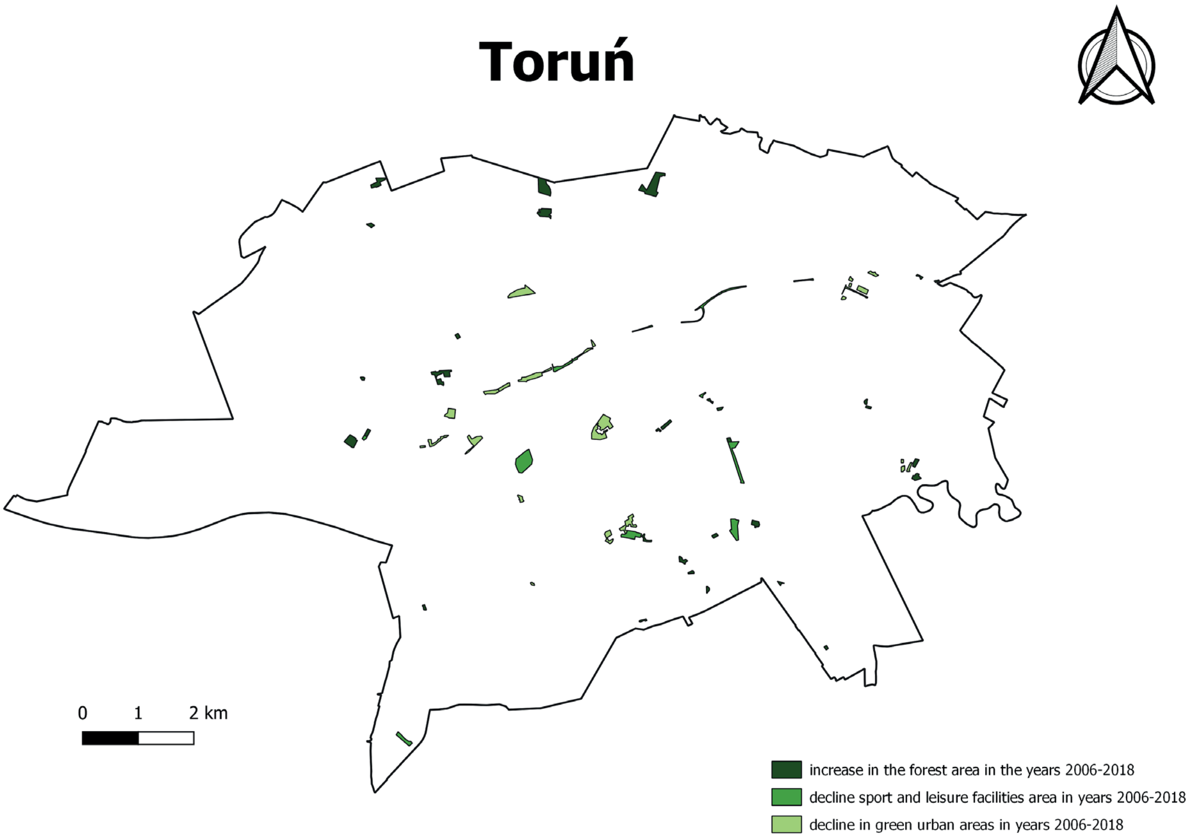

Fig. 3. Changes in the area of green spaces in Toruń
Source: own preparation.

was a decrease in green urban areas and sport and leisure facilities.

In the case of Toruń, spatial regularities in the changes in the area of green spaces were noticeable. As can be seen from the analysis of data in Toruń, the area of green urban areas decreased by almost 30 hectares. When analysing the prepared map bases with changes in the area of green spaces, a linear pattern of changes in the area of green urban areas can be seen (cf. Fig. 3).The authors decided on a different graphic presentation of the changes in the figures, so as to emphasize the relationships between linear changes in Toruń and random changes in Košice. In addition, the changes to the green urban areas and sports and recreation areas were small and hardly noticeable in one graphic.

The linear pattern of changes on the east-west line is due to the investment in road infrastructure in Toruń. The remaining changes in the area of green urban spaces in Toruń are of a dispersed character, without a clear pattern. Below, the figure shows new forest areas and areas where green urban areas and sports and leisure facilities have been replaced by another category of land cover.

To sum up, a negative balance of green spaces was recorded in Toruń and Košice. In the case of both cities, there is a noticeable increase in the area of forest areas, which is related to the natural forest succession. Moreover, in the case of Košice, spatial changes in green spaces are random, while in Toruń the changes are mainly linear.

Block II: Green space transformations

In 2012, there were 30 areas in Košice where the land cover changed into areas other than green spaces. In total, this change covered an area of 30.22 ha.

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This area was the starting area (2006) in relation to the calculation of changes in land cover in 2012.

In the years 2006–2012 in Košice, the first dominant change in green areas was the creation of non-specific areas (38%). The second dominant direction of changes was the creation of areas classified as industrial, commercial, public, military and private units on green spaces (26%). In the third place, in the years 2006–2012, mineral extraction and dump sites were created on green spaces (15%). The remaining changes in the purpose of urban green areas were of a marginal nature, i.e. they covered less than 10% of the total green areas. This fact, near the city's surface, is an almost imperceptible value. In 2006–2012, the creation of new green spaces was incidental and included the creation of new green spaces with an area of 6.84 ha, mainly in semi-natural areas.

In the years 2012–2018 in Košice, a significantly lower dynamics of changes in the creation of new areas in green spaces is noticeable. In the analyzed period, 12.51 ha of green spaces changed their purpose. The main direction of changes in 2012–2018 was the creation of new mining areas and landfills in green spaces (38%). Secondly, as in 2006–2012, industrial and commercial areas were created in green spaces (29%). It is important to underline the fact that in the years 2012–2018 green areas were more intensively transformed into the urban tissue. In total, these changes covered 4.06 ha, which accounted for 32% of all changes. The creation of new green spaces in 2012–2018 also had a small share. During this period, only 3.44 ha of new green spaces were created.

In Toruń in 2006–2012 59.43 ha of land classified as green spaces in 2006 underwent transformation. It is almost twice the changes in Košice, so the intensity of changes in Toruń is definitely greater. The main direction of transformations of green spaces in Toruń in 2006–2012 was the creation of new construction sites. It was they that occupied the largest area of green spaces (36%). As in Košice, industrial and service areas

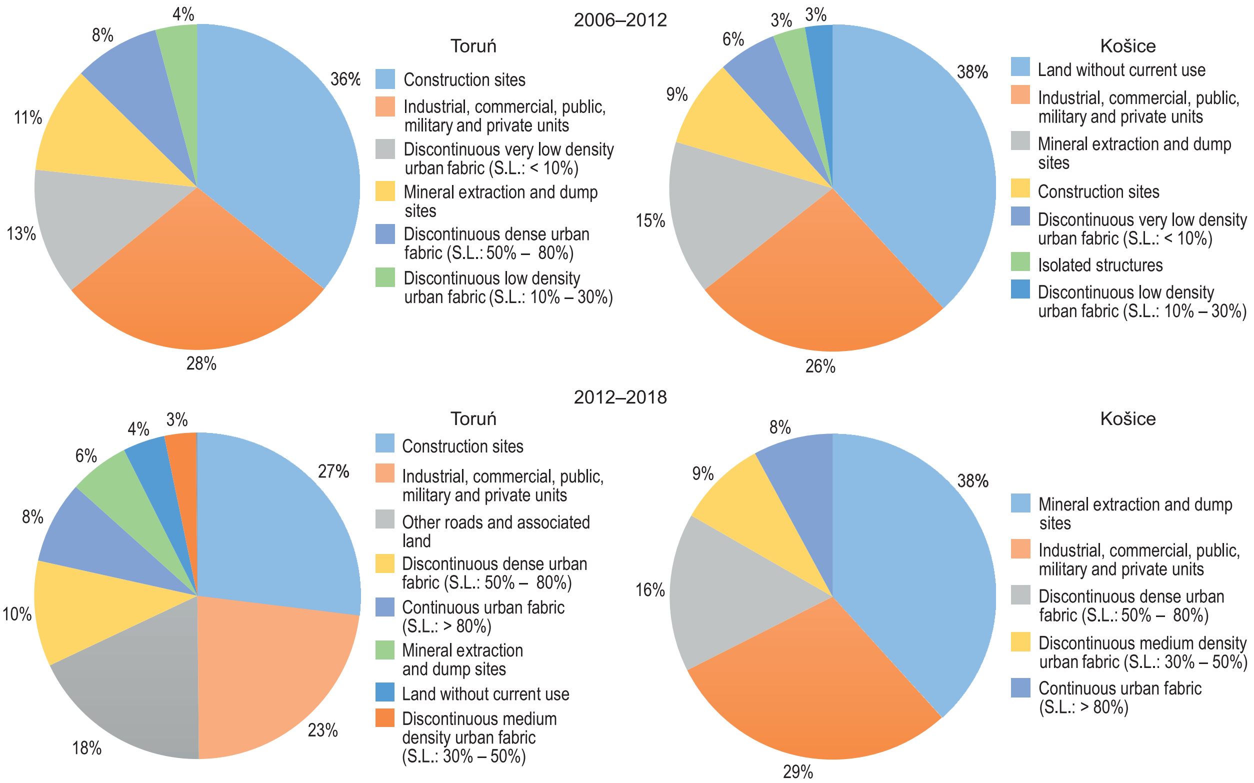

Fig. 4. The share of land developed in green spaces in 2006–2018 in Košice and Toruń
Source: own preparation.

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were built second to green spaces (28%). A share of more than 10% of changes was also recorded in areas with low intensity of urban tissue (13%) as well as areas of landfills and mining (11%). The remaining land cover categories converted to a low degree from green spaces. In the years 2006–2012, 20.04 ha of new green spaces were created in Toruń, which were mainly created in semi-natural areas (89.86%).

In Toruń, in 2012–2018, half of the transformation of green spaces into other areas involved the creation of construction sites as well as industrial and commercial sites (27% and 23%, respectively). A large share (18%) is also the creation of new roads in green spaces, which was indicated in the first block of the results. Compared to Košice in Toruń in 2012–2018, the share of land creation with urban tissue in green spaces is smaller and amounts to 21% in total.

In 2012–2018, the creation of new green spaces did not achieve a high result. In the given period, only 6.75 ha of new green spaces were created. These areas were created from various areas, incl. pastures, storage and industrial areas.

The categories of areas that arose from green areas in the analyzed period in both cities are very diverse. There is no one dominant direction for transforming green areas into another. In both cities, it is possible to point out that the green areas were transformed into industrial areas. However, in Toruń, in the years 2012–2018, a large percentage of green areas was designated for transport areas (roads), which can be seen in the linear system of changes in the area of green areas (Fig. 4).

Block III: CES analysis

The most significant regions of ecological problems are regions with unfavorable ecological conditions (Bratislava area, Košice basin, etc.) and then they are regions (territorial blocks) of ecological stability (eg Brezno, Malé Karpaty, Tokajské vrchy, etc.) (Reháčková & Pauditšová, 2007).

The following unstable landscape elements are in the cadaster of the municipality of Košice district Košice I. CES = The value of CES according to the Míchal methodology in the cadaster of the Košice I. is 3.006, which is assessed as a natural and nature-friendly landscape. There is a significant predominance of ecologically stable structures. In this, let us notice especially the high share of woodland and permanent grassland, occupying almost 6 million m^2 of the total area of the examined cadastral area. Ecologically unstable structures included urban areas to the extent of 1 822 000, i.e., built-up areas. According to Michal, we calculate the CES = 3.006. The following stable and unstable landscape elements are in the cadaster of the municipality of Toruń. CES = 2.648.

The following unstable landscape elements in the cadaster of the municipality of Toruń are quite balanced landscapes, in which the technical objects are relatively in accordance with the preserved natural structures, the result is a lower need for energy-intensive deposits. The value of CES according to the Míchal methodology in the cadaster of the Toruń is assessed as a quite balanced landscape.

It is clear from the results of CES that the city of Košice I. shows values close to natural structures, as stable elements prevail over unstable ones. The city of Torun is similar, but it is defined in the second category as quite balanced landscapes. Following the results of the research carried out in the previous sections, this article also confirmed the fact of an increase in green space in both cities, but in the case of the city of Toruń, this decrease is much more pronounced. This fact is also visible in the result of the CES calculation within the analysed cities, when the city of Košice shows results closer to the natural structures of the area. Another fact that was confirmed to us in the CES calculation is that the only component of greenery that increased its area was forests. In both analysed cities, the area of forests increased, while in Košice there were more than twice as many forests as in Toruń. When analysing the spatial distribution of changes in the surveyed cities, it is necessary to point out that in the case of the analysed area of Košice I., these changes were concentrated in the northern and central part of the city and mainly concerned the creation of new forest areas. In the coming years, attention will need to be paid to the transformation to green spaces in cities. As a result of the constantly increasing urbanisation in both Slovakia and Poland, the population in cities

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Table 5. The value of CES according to the Miklós methodology in the cadastre of the municipality of Košice I. and Toruń

City	Landscape elements km^2					
	Field	Meadows	Gardens	Forests, water, wetlands	Others	Total CES
Toruń	5,18	0,00	3,59	44,86	0,31	0,89789
Košice	0,001504	0,0054	0.391	0,071154	0,000759	0.57288

Source: own preparation.

is expected to double almost twice. The problems in connection with the growing development in cities and the loss of green areas are already evident today, as evidenced by the results of research and statistics from European Healthy Cities Network 2022. Instead of new construction on a green field, the solution within the housing policy can be, for example, the use of old buildings, factories in short, brownfields for these purposes. However, the disadvantage of this solution is the high initial financial costs, which discourages potential investors and the city from making effective use of these spatial aspects of the territory (Míchal, 1985; Miklos, 1986; National Network of Healthy Cities CR, 2022).

Another possible tool that many European cities are starting to use is parking spaces in central parts of cities. These concrete areas are available for the conversion of green areas as part of the displacement of passenger car traffic. Parking houses, on the other hand, serve as points of reference for possible parking on the outskirts of the city, while residents can then get to the city centre via ecological public transport, on shared bicycles or on foot. This concept has been introduced in many cities by, for example, the Netherlands, Belgium, Italy, Norway, Denmark, etc. (National Network of Healthy Cities CR, 2022). In our opinion, this concept within the possible transformation of green spaces in the central parts of the analysed cities would be a suitable way to increase this number of green spaces in the centre of the analysed cities in Poland and Slovakia.

The value of CES according to the Miklós methodology in the cadastre of the municipality of Košice I. is 0.57288 = the area is moderately stable. The value of CES according to the Miklós methodology in the cadastre of the municipality of Toruń is 0,89789 = the area is moderately stable. Košice and Toruń are characterised by good ecological resilience, but the larger forest area in Košice has a positive effect on the CES value. It is therefore necessary to use tools and resources to introduce protective measures in the city's landscaped area and to support the recultivation of the area.

DISCUSSION

As Jirout (2016) and his team point out, the growth of forest areas within the city space is an important element in creating ecological stability. This is confirmed by the research carried out, which clearly shows the increase in forest area in Toruń and Košice in 2006–2018 and the positive value of the CES index. According to Vyleta (2019), in order to maintain the high ecological stability of the urban landscape, it is necessary to prefer spatial development that takes into account the growth of ecologically stable areas, such as green spaces. Such planning primarily respects the assumptions of the sustainable city (DeFries et al., 2007), retains the shape and character of the cultural landscape (Mörtberg et al., 2007) and meets the requirements of the inhabitants (Miller & Hobbs, 2002), which will also translate into the overall ecological stability of the city and landscape. The ecological stability of the city's landscape, apart from the ratio of stable to unstable elements, is influenced by their fragmentation.

Tárníková and Muchová (2018) indicates that the high fragmentation of ecologically stable areas negatively affects the ecological stability of the entire urban system. In the context of this study, it can be concluded that the changes taking place in the green spaces in Košice and Toruń are highly fragmented. Thus, they negatively affect the ecological stability of the city's landscape. On the other hand, Gałaś and Gałaś (2009), when examining ecological resistance, believes that the very idea of ecological stability

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of a landscape assumes that with an increase in both the area share of stable elements, the area becomes more ecologically stable. By being stable, it is more resistant to various types of anthropopressure that destabilize the ecological resilience of the landscape. In the case of Toruń, we can clearly see that strong anthropopressure (creation of a cross-diameter route) expressed in a linear decline in green spaces contributed to a decrease in the CES index in the city. The city, keeping the green spaces in this place, would increase its ecological stability. However, the dynamic development and the pressure to modernize the city's transport network led to the loss of green spaces, which are valuable from the point of view of ecological stability.

According to research by Hruška and Petrovič (2018), ecological stability appreciates forest and semi-natural areas. In 2006–2018, over 320 ha of land classified as forests by the Urban Atlas were added to Košice. This undoubtedly contributed to an increase in the ecological stability of the city's landscape. However, such changes may be associated with a change in land cover categories, and not with the creation of special new forest areas. It is important to underline the fact that changes in the area of creating new forest areas occupy a large area, and therefore their impact on ecological stability will be much greater than in the case of fragmentary changes in Toruń.

CONCLUSIONS AND SUMMARY

As shown by the research, increasing the area of green spaces has a positive effect on the development of ecological resilience. It is refreshing that both cities increase the area of green spaces by increasing the area of forests. The creation of new GUA and sport and leisure facilities would also have a positive impact on ecological resistance, however, in the limited space of the city, the process of creating these areas is difficult.

In the analyzed period, there was an increase in the area of green areas in both cities. This increase was definitely influenced by the increased forest succession, as the largest number of these areas was increased. In Toruń and Košice, a downward trend in the construction of new green urban areas and sports and recreation areas is noticeable. The main direction of the transformation of green areas in Košice is the creation of new warehouse space in green areas, while in Toruń, green areas mainly include areas related to the creation of new industrial or commercial areas. It is disturbing that the creation of new green areas in Košice and Toruń is negligible. Košice and Toruń are characterized by good ecological resistance, but a larger forest area in Košice has a positive effect on the CES value.

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