https://doi.org/10.26565/2410-7360-2025-62-33
UDC 502.15:712.4]:911.375(477)
Received 24 March 2025
Accepted 9 May 2025

Green infrastructure of Ukrainian cities in the context of the European Green Deal

Nadiya Maksymenko [1]
DSc (Geography), Professor, Head of the Department of Environmental Monitoring and Protected Areas Management, [1] V.N. Karazin Kharkiv National University, Kharkiv, Ukraine,
e-mail: maksymenko@karazin.ua, http://orcid.org/0000-0002-7921-9990;
Vilina Peresadko [1]
DSc (Geography), Professor, Department of Physical Geography and Cartography,
e-mail: vilinaperesadko@karazin.ua, https://orcid.org/0000-0002-2439-2788;
Alina Hrechko [1]
Lecturer, Department of Environmental Monitoring and Protected Areas Management,
e-mail: a.a.hrechko@karazin.ua, https://orcid.org/0000-0001-9987-2586;
Svitlana Burchenko [1]
PhD (Earth sciences), Senior Lector of the Department of Environmental Monitoring and Protected Areas Management,
e-mail: s.burchenko@karazin.ua, https://orcid.org/0000-0001-5366-5397;
Hanna Skryhan [2]
PhD (Geography), Associate Professor on Ecology,
[2] Erda Research, Technology, Education; Hague, Netherlands,
e-mail: skrane4ka@gmail.com, https://orcid.org/0000-0002-3767-6923

ABSTRACT

Introduction. Increasing urbanisation, climate change and environmental challenges highlight the importance of a comparative assessment of the provision of green infrastructure in Ukrainian cities to improve the quality of the urban environment and the lives of citizens. A comparative assessment of the provision of green infrastructure in Ukraine's regional centres will help identify the level of green space development in each city, as well as their current problems and potential for further development. Such an analysis will enable local authorities and policy makers to take the necessary measures to improve the condition of green infrastructure and increase its accessibility to all city residents.

The purpose of article. To determine the peculiarities of the formation and functioning of green infrastructure (GI) in the cities-regional centres of Ukraine, to compare the provision of the population with green areas in different administrative units of these cities.

Research methods. To obtain statistical information on the population of each district of the city and the area of individual green areas, the method of statistical analysis and interpretation of remote sensing materials was used. For this purpose, satellite images from the Google Earth mapping service were used. Mathematical calculations were made in accordance with the generally accepted Green Index, which was defined as the ratio between the area of a district (city) and the number of its inhabitants.

Main findings. The geographical analysis based on geodata and indices allowed us to assess the state of green areas in cities, identify the lack of green areas, and decide on the necessary measures to increase and improve green space. According to the results of the analysis, the cities with the most green infrastructure are Uzhhorod, Donetsk, Ternopil, Kropyvnytskyi, Rivne and Kharkiv, where the green indices are 136, 45, 39, 31, 29 26. This indicates that cities are actively working to preserve green areas and create comfortable environmental conditions for residents. On the other hand, in cities such as Luhansk (0.78), Sumy (2.73), Odesa (2.87), Mykolaiv (3.3), and Poltava (3.58), the area of green areas reaches catastrophic levels. They are more than 5 times behind the average European standards. The overall conclusion is that the state of green infrastructure in Ukrainian cities is diverse and requires attention at different levels. Cities that are leading the way in creating and maintaining green spaces show that it is possible and contribute to improving the quality of life of their residents. At the same time, cities with an insufficient amount of green space lag behind the standards, which can have a negative impact on health and the overall state of the urban environment.

Scientific novelty and practical value. This study for the first time summarises the material on all regional centres of Ukraine regarding the provision of green infrastructure, calculates green indices, conducts spatial analysis and develops relevant recommendations.

Keywords: *Green Infrastructure, Green Index, Districts, Green Zone, Green Corridors, urban landscape, European Green Deal.*

In cites: Maksymenko Nadiya, Peresadko Vilina, Hrechko Alina, Burchenko Svitlana, Skryhan Hanna (2025). Green infrastructure of Ukrainian cities in the context of the European Green Deal. Visnyk of V. N. Karazin Kharkiv National University. Series Geology. Geography. Ecology, (62), 437-451. https://doi.org/10.26565/2410-7360-2025-62-33

Relevance of the research topic. Anthropogenic pressure on the environment is increasing every year. In urban environments, the conflict between socio-economic development and the natural ecosystem [1] becomes more noticeable due to: an increase in the temperature of the city compared to the surrounding rural areas (or the urban heat island effect), which is facilitated by an increase in the amount of asphalt pavement, which changes the thermal and reflective capacity of the surface [2], air pollution due

to intensive traffic, industrial enterprises, changes in the structure of natural landscapes, for example, filling in natural gullies for the construction of high-rise buildings and increasing pressure on the lithosphere due to them, destruction of natural biodiversity, regulation of rivers, interference with the direction of surface runoff, destruction of natural forests, etc. [3]. Therefore, given the pressure of the urban environment on the environment and the projected rapid growth of the urban population by 2025, it is necessary to take measures to reduce pressure and improve the urban environment to meet the needs of sustainable development.

The use of the concept of green infrastructure in the urban environment is one of the best methods for coordinating environmental, social, and economic development and can serve as a key to achieving important goals of the sustainable development strategy [4,5].

State of the art, main works. The development of the concept of green infrastructure began in the 1980s as a way to manage surface runoff [6], but article [7] highlights that the rapid growth in demand for green infrastructure and scientific work on the development of the concept to ensure the sustainability of the urban environment dates back to 1995.

Approaches to the definition of the term "green infrastructure" are quite diverse, in the article by Laver S. and Taylor [8] and Neumann S. et al. [9] define it as a planned or managed spatial structure and network of interconnected environmental objects, natural areas, open spaces and landscapes, the European Commission defines it as: a strategically planned network of natural and semi-natural areas with different ecological features, designed and capable of providing a wide range of ecosystem services [10]. And the UK Green Infrastructure Guidelines define green infrastructure as: "a strategically planned and implemented network that includes a wide range of high quality green spaces and other disaster facilities" [11]. Despite the difference in interpretations, the key aspects of green infrastructure are that it is an object of both natural and semi-natural origin that can improve the urban environment.

The use of the green infrastructure concept provides a number of benefits that ensure the sustainability of the territory [12-16]:

- creation of habitats for the development of biodiversity;
- creation of places for recreation and support of mental and physical health;
- moisture retention and stormwater management;
- maintaining and ensuring the microclimate, including the reduction of the urban heat island phenomenon;
- purification of atmospheric air;
- carbon sequestration;
- oxygen production;
- optimization of urban space differentiation;
- noise reduction, etc.

The concept of green infrastructure is closely related to other important concepts for ensuring the sustainability of the urban environment, such as the European Green Deal.

The European Green Deal is a strategic initiative of the European Union aimed at achieving climate neutrality by 2050 and transition to sustainable development that minimizes negative impact on the environment [17]. The provisions of the European Green Deal set out a strategy for transitioning the economy to a circular economy, which will make it possible to transform the economy into a sustainable one and change climate and environmental challenges into opportunities [18]. The Green Deal, according to [19], includes: stimulating the process of carbon sequestration, reducing energy consumption in construction, and restoring ecosystems to increase their adaptation to climate change. These aspects of the Green Deal can be achieved by creating new elements of green infrastructure and expanding existing ones.

Green infrastructure, such as forests, wetlands, and other natural systems, can help regulate the water balance, reduce the effects of floods and droughts, and mitigate the risks associated with extreme weather events [20]. Restoring and expanding natural environments is a priority for biodiversity conservation [21]. The European Green Deal provides for the creation and maintenance of ecological corridors that allow animals and plants to migrate and adapt to climate change [22]. Green infrastructure in urban areas helps to clean the air, reduce air temperature due to the effect of urban heat islands, and improves the mental and physical health of the population [23]. Green infrastructure contributes to the efficient use of resources by improving conditions for water storage, air purification, and reducing ground pollution, which is in line with the principles of the circular economy, which is the basis of the European Green Deal [24].

Thus, green infrastructure is a critical component in the implementation of the European Green Deal, and it improves the established sustainable ecosystems that help mitigate climate change, preserve biodiversity, and improve the quality of life of citizens.

The aim of the study is to identify the features of the formation and functioning of green infrastructure (GI) in regional centers of Ukraine, and to compare the population's access to green areas across different administrative units of these cities.

Research methods. In order to assess the effectiveness of biodiversity conservation measures in Ukrainian cities, such as the creation and develop-

ment of green areas, it is necessary to perform more than just a theoretical analysis. To fully cover the study, we chose to assess the availability of parks, gardens, squares, and other recreational facilities. The calculation did not include single trees, city cemeteries, and neighborhood plantings due to their small area and insufficient landscaping.

To obtain statistical information on the population of each city district and the area of individual green areas, the method of statistical analysis and decoding of remote sensing materials was used. For this purpose, satellite images from the Google Earth mapping service [25] were used to estimate the area of parks, squares, and forests that were not included in the general data or Natura 2000 environmental projects.

The mathematical calculations were made in accordance with the generally accepted Green Index, defined as the ratio between the area of a district (city) and the number of its inhabitants.

$$GI = P / N,$$

where: P - green area of the district, м^2
N - population, persons.

The conclusions drawn based on these calculations were compared with European standards for urban greening requirements.

Research results. Green areas in Ukrainian cities play an important role in creating a healthy and livable environment for residents. They include parks, squares, gardens, forest parks and other green areas.

The number and size of green areas in different cities in Ukraine can vary considerably depending on their geographical location, size, and the availability of relevant infrastructure projects. Regional centers and large cities usually have more green areas as they are the administrative, cultural and tourist centers of the regions.

However, not all cities in Ukraine have sufficiently developed green infrastructure. This may be due to insufficient funding, improper planning of urban development projects, and a lack of awareness of the importance of green areas for the quality of life of residents. Therefore, it is an urgent task to increase attention to green infrastructure and implement strategies for its development in all Ukrainian cities.

To assess the real situation, we conducted a study of the provision of green infrastructure facilities to the population of Ukrainian cities and regional centers (Table 1).

Let's analyze each city separately in terms of the Green Index.

Cherkasy. It covers an area of 75 km² and has a population of 269,800 people. The calculated area of green areas in the city is 1.8 km², which accounts for 6.67 m² of green space per capita.

The green index in the city is as follows:

Sosnovskyi district 8.32 m^2/person (Cherkasy City Park 'Sosnovyi Bor'; Small Victory Park; Cherkasy Zoo; City Hospital Park; Bohdan Khmelnytskyi Square; Yunist Park; Druzhba Park; Nadiia Park; Botanical Garden; Green Grove);

Prydniprovskyi district 9.60 m^2/person (Park Khimikiv; Kozatskyi Park; Park named after Sergeant Smirnov; Valley of Roses; Dniprovskyi Park; Square on the Square of the Three Hundredth Anniversary of the City; Sobornyi Park; Cherkaska Bor; Yuvileinyi Park; Solnechnyi Park; Sosnovskyi Park; Sportvnyi Park; Lisova Pisnia Park).

Examples of the most favourite parks of the city's residents [48]:

- Valley of Roses Park. Here, every resident and visitor of the city can enjoy the coolness of one of the mini-lakes or fountains, stroll along the winding alleys, and relax on a bench.
- Sosnovy Bor Park. It is the largest and oldest park in the city, with more than 70 valuable and exotic trees.
- Victory Park. It has shady alleys, beautiful cascading ponds and fountains. There are many monuments dedicated to various heroic events in Victory Park.
- Park Khimikiv. The highlight of the green area is a paved alley that runs along the perimeter of the entire park [48].

Chernivtsi covers an area of 152.7 km^2 and has a population of 264,300 people. The calculated area of green areas is 1.22 km^2, where the green index per capita is 4.62 m^2.

The green index in each district of the city is represented by green areas [49] and is as follows:

- Pervomaiskyi district 2.05 m^2/person (Yurii Fedkovych Park; Horyachyi Urban Reserve Park; Chernivtsi Dendrological Park);
- Sadhirskyi district 0.07 m^2/person (Sadhirskyi Park);
- Shevchenkivskyi district 36.93 m^2/person (Taras Shevchenko Central Park of Culture and Recreation; Shyler Park; Botanical Garden of Yuriy Fedkovych Chernivtsi National University; Zhovtnevyi Park; Chernivtsi Dendrological Park).

Chernihiv. It covers an area of 79 km² and has a population of 282,700 people. The calculated area of green areas in Chernihiv is 3.6 km², which is 12.73 m² of green space per capita.

Green areas, such as parks and squares, play a significant role in creating natural areas for recreation for local residents and visitors. Among the most popular green spaces are the following [50]:

- Central Park of Culture and Recreation. It is a traditional place for recreation and leisure for local residents, where mass events and festivities are often held.

Table 1

Components of the Green Index of Ukrainian Cities and Regional Centers

City	Population as of 01.01.2023 thousand people [26]	Area as of 01.01.2023, km² [27]	Area of the city's green zone, km²	GI, %	Green Index, m²/person
Cherkasy	269,8	75	1,8	2,4	6,67
Chernihiv	282,7	79,0	3,6	4,6	12,73
Chernivtsi	264,3	153,0	1,2	0,8	4,62
Dnipro	968,5	409,7	5,0	1,2	5,16
Donetsk	901,6	358,0	40,7	11,4	45,14
Ivano-Frankivsk	238,2	83,7	1,4	1,7	5,88
Kharkiv	1421,1	350,0	37,7	10,8	26,55
Kherson	279,1	65,2	1,9	2,9	6,66
Khmelnytskyi	274,5	93,0	1,1	1,2	4,01
Kropyvnytskyi	219,7	115,0	7,0	6,1	31,86
Kyiv	2952,3	839,2	54,9	6,5	18,60
Luhansk	397,7	286,0	0,3	0,1	0,78
Lutsk	216,0	42,0	2,4	5,7	11,11
Lviv	717,3	149,0	11,4	7,7	15,89
Mykolaiv	470,0	259,8	1,6	0,6	3,30
Odesa	1010,5	162,4	2,9	1,8	2,87
Poltava	279,6	112,0	1,0	0,9	3,58
Rivne	243,9	64,0	7,1	11,1	29,23
Simferopol	338,3	107,0	2,0	1,9	6,02
Sumy	256,5	95,0	0,7	0,7	2,73
Ternopil	225,0	86,0	8,9	10,3	39,56
Uzhhorod	115,4	60,0	15,7	26,2	136,05
Vinnytsia	369,7	113,0	1,6	1,4	4,19
Zaporizhzhia	710,1	334,0	5,0	1,5	7,00
Zhytomyr	261,6	65,0	2,3	3,5	8,75
Ukraine	***13683,4***	***4556,0***	***219,1***	***4,8***	***16,02***

- Bohdan Khmelnytskyi Square. Located in the historic centre of the city. The square has the shape of an irregular rectangle, which is why it attracts residents and visitors.

- Alley of Heroes. It is here that the largest number of cultivars can be found among other park areas in Chernihiv.

- Boldina Gora Park. The highest point of Chernihiv, it is home to one of the largest necropolises in Ukraine, consisting of 232 mounds, which makes it a historical attraction.

Dnipro. This city is one of the largest in Ukraine. As of 2023, the territory of the city of Dnipro is 409.7 km², and the population is 968.5 thousand people [26]. The calculated area of green areas in the city of Dnipro is 5 km², which accounts for 5.16 m² of green areas per capita (Table 1).

The largest and most popular green areas in the city include [29]:

- Globa Park: One of the largest parks in the city, offering large green areas for recreation, sports, and walking.

- Metallurgists Park: Located on the banks of the Dnipro River, this park offers beautiful views of the river and picnic areas.

- Heroes of the Maidan Square: Known for its architectural beauty and cultural events.

- Taras Shevchenko Park: A large park with many different plants and alleys.

In the city of ***Donetsk,*** green areas cover a total of 40.7 km², which accounts for 11.37% of the city's overall territory. The average green index is 41.46 m² per person; however, this figure varies significantly across different districts. The highest green index is recorded in the Petrovskyi district – 146.34 m²/person – indicating a large amount of green space relative to its relatively small population. The Proletarskyi district also demonstrates a high index – 91.3 m²/person. In contrast, the lowest values are found in the Voroshylovskyi (6.55 m²/person) and Budionivskyi (11.33 m²/person) districts.

Petrovskyi district has the highest share of green infrastructure in relation to its total area (18.96%), while Budionivskyi has the lowest (1.25%).

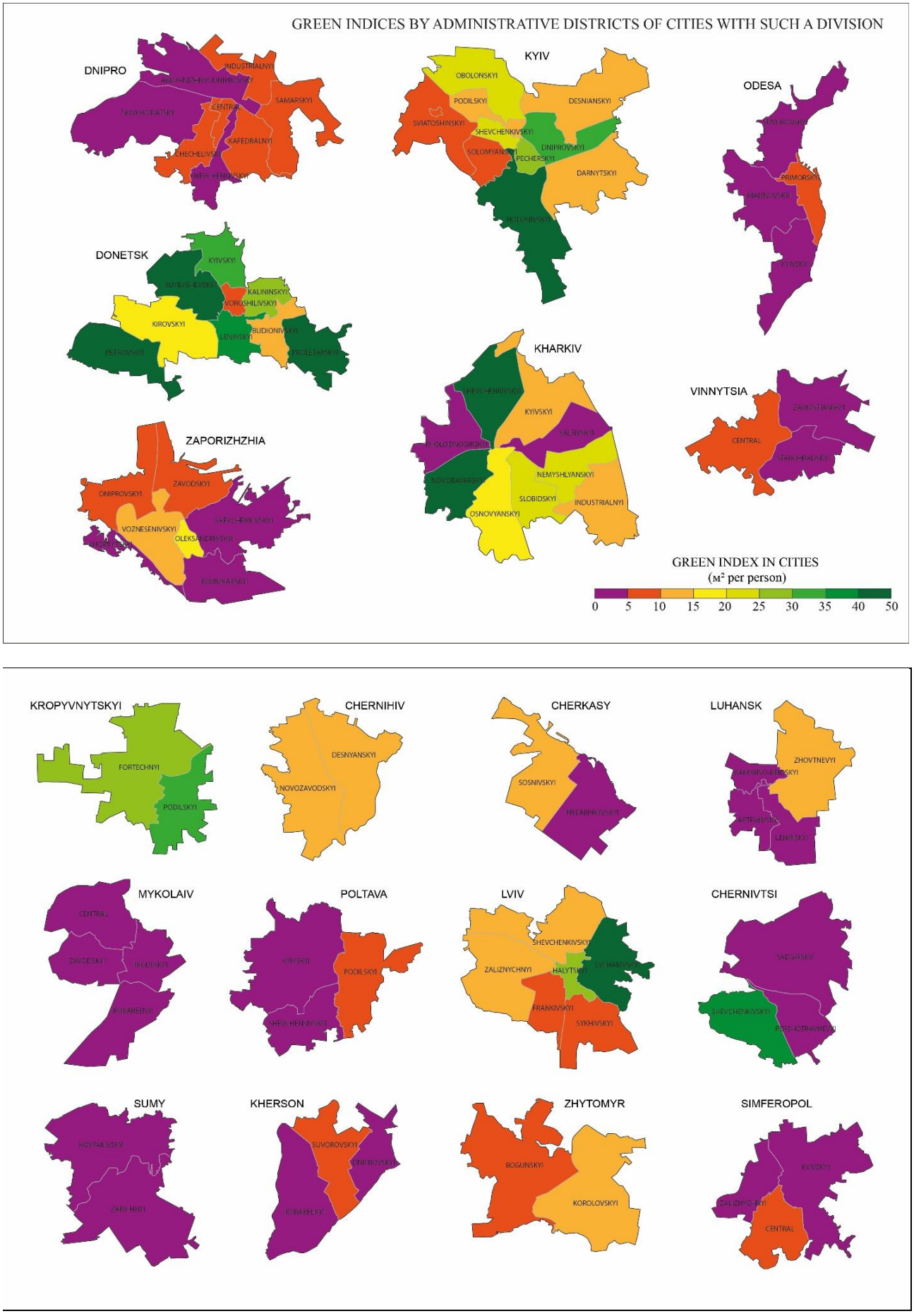

Fig. 1. Green indices by administrative districts of cities with such a division

Donetsk's green zones include parks, squares, boulevards, forest parks, and riverside plantings. Among the most notable sites are:

Shcherbakov Park of Culture and Leisure – one of the city's largest and oldest parks, located near the Voroshylovskyi district. It features lakes, pedestrian alleys, attractions, and recreational areas.

The Botanical Garden of Donetsk National University – an important scientific and natural landmark that also serves recreational purposes.

Ivano-Frankivsk. It covers an area of 83.7 km² and has a population of 238,200 people [26]. The calculated area of green areas in the city is 1.4 km², which accounts for 5.88 m² of green space per capita.

The largest and most popular green spaces in the city include [32]:

- Warriors-Internationalists Park. It has a large number of flower plantings and a play area for children.
- Taras Shevchenko Park. Locals call it a museum of nature, because exotic trees and shrubs grow here, which were once brought from nurseries in Poland, France, and America.
- Youth Park. The second largest park in the city, it is a quiet and peaceful place for city residents.
- Railway Station Square. It is located opposite the train station and serves as a place for recreation for guests and residents of the city [23].

Kharkiv. The city has a developed green infrastructure and a large number of green areas. As of 2023, the territory of the city of Kharkiv is 350 km² and the population is 1,421,000 people. The estimated area of greenтarea in the city of Kharkiv is an impressive 37.73 km², which translates into 26.55 m² of green space per inhabitant [3, 16].

There are many parks and squares in Kharkiv that serve as green areas for recreation, leisure and recreation for city residents. The most famous and popular ones are worth highlighting:

- The Central Park of Culture and Recreation is one of the largest and most visited parks in Kharkiv. It includes large green areas, lakes, attractions and well-equipped recreation areas for every taste.
- Taras Shevchenko Garden - located in the heart of the city. The garden features well-maintained alleys, picturesque artificial ponds and cultural and memorial objects.
- Victory Square - located in the northern part of Kharkiv. The square attracts visitors with its wide lawns, playgrounds and cosy atmosphere.
- Sarzhyn Yar is a unique natural green area in the shape of a ravine located in the south-east of Kharkiv. It is a favourite place for walks and outdoor activities, as well as a source of natural mineral water, which is favoured by the city's residents.

The territory of the city of ***Kherson*** is 65.2 km², with a population of 279,100 inhabitants. The area of green zones in the city is 1.9 km², which accounts for 6.66 m² of green areas per capita (Table 1).

The green index in the city is as follows:

- Dniprovskyi district 4.20 m²/person (Prydniprovskyi Park; Shumskyi Park);
- Korabelnyi district 1.28 m²/person (Shumenskyi Park; Buzkovyi Hai);
- Suvorovskyi district 6.25 m²/person (Kherson Fortress Park; Park of Glory; Shevchenkivskyi Park; Monument of landscape art of the Kherson City Lyceum) [46].

The area of ***Khmelnytskyi*** is 93.05 km². The population is 274,500 people. The area of green zones in the city is 1.102 km², which gives 4.01 m² of green areas per capita (Table 1).

The largest green areas of the city are Mykhailo Chekelan Culture and Recreation Park; Love Island; Taras Shevchenko Square; Ivan Franko Park; Youth Park; Pioneer Square; Square of Sorrow; Podillia Arboretum; Khmelnytskyi National University Botanical Garden; Pivdennyi Buh River Park; and Zarichchia Park [47].

Kropyvnytskyi. The city covers 115 km² and has a population of 219,700 people. The calculated area of green areas in the city is 7 km², which accounts for 31.86 m² of green space per capita.

Parks and squares in Kropyvnytskyi play an important role in improving the quality of life of the local population and creating a pleasant environment for recreation and entertainment. The most favorite green spaces in the city include [35]:

- Central Square. This is perhaps the only place with shade in the central part of the city where all visitors and residents of the city can hide from the heat in summer.
- Cossack Island Park. Located on the left bank of the Ingul River. This magical corner was created in 1937 and is an incredibly picturesque place for residents.
- Victory Park. It is the oldest park in the city, with bicycle paths, outdoor exercise equipment, and a sports ground, and for more than two centuries it has been a place for mass festivities and recreation.
- Dobrudzha forest area. This is one of the most favorite places for students to enjoy the silence and relax in the fresh air among the trees.

Kyiv. The capital of Ukraine is famous for its developed green infrastructure and vast green areas. The territory of the city of Kyiv is 839 km², and the city's population is 2,952,300 people. The calculated area of green spaces in Kyiv is 54.9 km², which translates into 18.6 m² of green space per capita.

There are many large parks and squares in Kyiv that serve as green spaces for the local population and visitors. Some of the largest and most popular green spaces include [33, 34]:

- Holosiivskyi Park: One of the largest parks in

the city, located in the southern part of Kyiv. It serves as an important recreational area for residents and has a large botanical garden.

- Mariinsky Park covers an area of 8.9 hectares and boasts more than 80 species of trees. Exotic plants grow here, such as Amur velvet, Canadian boxwood, Schwedler maple, linden trees, Japanese sophora, and, of course, Kyiv chestnuts.
- Hydropark: Located on an island in the middle part of Dnipro, this park offers large green areas, beaches, and attractions for recreation.
- Taras Shevchenko Square: Located in the central part of the city, this square is one of the most popular green areas for walking and relaxing.

As of 2024, the city of ***Luhansk*** has an area of 286 km^2 and a population of 397,700. The city's green areas cover 0.31 km^2, with a green index of 0.78 m^2 per capita (Table 1).

The green index is calculated for each district of the city formed by the following objects and is as follows (the toponymy of the city has been preserved in the pre-war period) [36]:

- Artemivskyi district 0.29 m^2/person (Heroes of the Great Patriotic War Square; Druzhba Forest Park);
- Zhovtnevyi district 13.33 m^2/person (May Day Park; Memory Square; Taras Shevchenko Botanical Garden);
- Kamiano-Bridskyi district 0.72 m^2/person (M. Gorky Park of Culture and Recreation; Revolution Square);
- Leninsky district 1.31 m^2/person (Park of Glory of Civil War Heroes; Park-Museum of Anthropological Steles and Polovtsian Stone Statues; Young Guard Square).

Lutsk. It has a territory of 42 km² and a population of 216,000 people. The calculated area of green spaces in Lutsk is 2.4 km², which accounts for 11.11 m² of green space per capita.

Among the favorite green areas of this city are [37]:

- Lesia Ukrainka Park. It is located in the very center of the city, has a large number of alleys, ancient trees that serve as protection from the heat in summer.
- Square of the Heroes of the Maidan and the Heavenly Legion. It is a cozy place where locals like to relax.
- Park named after the 900th anniversary of Lutsk. It has a lot of trees and clean air, so it is popular with residents who are actively involved in sports.
- Oak Grove. It is one of the favorite places for recreation, especially in winter, when many children and adults gather to go down the slides.

Lviv. The city has an area of 149.0 km² and a population of -717,300 people. The calculated area of green areas in Lviv is 11.4 km², which accounts for 15.89 m² of green space per capita. Parks and squares are important for recreation for local residents and visitors [3, 38]. The most popular ones in the city are:

- John Paul II Square. It is especially popular with visitors in the spring, as there are more than 120 sakura trees planted here, which bloom in May.
- Stryiskyi Park. It is one of the largest parks in Lviv, with more than two hundred species of plants, and is of great historical value to the locals.
- High Castle. The park includes Castle Hill, where the remains of the historic “High Castle” are located, and gathers a large number of tourists who can enjoy the panoramas of the city.
- Park Znesennya. It is ideal for cycling, skiing in winter, and hiking for residents and tourists alike [38].

As of 2023, the population of ***Mykolaiv*** is 470,000 people, and the city covers 260 km^2. The area of green areas is 1.6 km^2, which is 3.3 m^2 per capita.

The green index for each district of the city is formed by such green areas and is as follows:

- Zavodskyi district 4.03 m^2/person (Lexi Park; Young Heroes Park; Skazka Children's Garden; Council of Europe Square);
- Ingulskyi district 2.68 m^2/person (Yunist Park; Zoological Park; St. Nicholas Square);
- Korabelnyi district 0.63 m^2/person (Korabelnyi Park; Druzhba Park; Soldier Square; Bohoyaslovskyi Park; Sosnovyi Forest Park);
- Central district 3.51 m^2/person (Sixty-eight Paratroopers Square; Victory Park; People's Garden; Chestnut Square; Taras Shevchenko Park) [39].

Odesa. It covers an area of 162.4 km² and has a population of 1010.5 people. The calculated area of green areas in the city of Odesa is 2.9 km², which accounts for 2.87 m² of green space per capita.

The largest and most popular green areas in the city include [40]:

- Shevchenko Park: Located in the central part of the city, this park is one of the largest and oldest green spaces. It offers beautiful alleys, cascades of fountains and a fabulous landscape.
- Botanical Garden of Odesa University: This botanical garden impresses with its variety of plants and exotic species.
- Park of Glory: Located on the Black Sea coast, it offers great views, sea breezes, and places to relax.
- Leonid Utesov Square: Known for its architectural beauty and cultural events.

Poltava. The city covers an area of 112 km² and has a population of 279,600 people. The calculated area of green areas in the city is 1 km², which accounts for 3.58 m² of green space per capita.

This city does not have a large amount of green infrastructure, but the most popular among them are

the following [41]:

- Birch Square. Located in the very center of the city, it got its name because of the species composition of the trees that dominate it, and it is one of the most picturesque and pleasant streets for walking.
- The Corps Garden. There are about 70 species of trees and shrubs here, with flower beds of peonies and roses and other flowers. There are many rare species of trees.
- Victory Park. Folk festivals are often organized on its territory, and there are waterfalls and outdoor tennis courts.
- The park on the estate of Mr. Myrnyi. It preserves trees and bushes planted by the writer, as well as three hundred-year-old oaks on the bank of the pond.

Rivne. As of 2023, it has an area of 64 km² and a population of 243,900 people. Green areas in the city cover 7.13 km², which corresponds to 29.23 m² of green space per capita.

In the city of Rivne, there are parks and squares that serve an important function of green spaces for local residents and visitors. Among the largest and most favorite green areas are [42]:

- Yubileiny Park. A wonderful green area of the city, where residents love to spend time, is replenished with new entertainment areas every year.
- Taras Shevchenko Park. It is conditionally divided into 5 zones: quiet recreation, active recreation, entertainment facilities, sports and children's sector.
- Lebedynka Park. One of the most favorite places for recreation for local residents.
- Hoshcha Park. One of the 5 oldest parks in Ukraine, its greatest value is rare tree species brought here from many countries of the southern hemisphere.

Simferopol covers an area of 107 km^2 and has a population of 338,300 people. The calculated area of green zones is 2.04 km^2, which accounts for 6.02 m^2 of green areas per capita (Table 1). The green index in the city is formed by various parks [43] and is as follows:

- Railway District 5.91 m^2/person (Yuri Gagarin Park; Soldiers of Internationalists Square; Heroes of Social Work Square; Victory Square; Vladimir Vysotsky Square; St. Luke of Crimea Square);
- Central district 0.54 m^2/person (Trenov Park; Catherine's Garden Park; Salgirka Park; Taras Shevchenko Park; Seminarsky Square);
- Kyivskyi district 0.62 m^2/person Children's Park; Peace Square; Simferopol Arboretum; Hryhorii Potemkin Square) (place names have been preserved since the pre-war period).

The territory of the city of ***Sumy*** is 95.0 km^2, with a population of 256,500 people. The calculated area of green areas in Sumy is 0.7 km², which accounts for 2.73 m² of green space per capita.

Among the most popular green places for recreation in this city are the following [44]:

- Kozhedub Park. It serves as a cultural recreation for residents and guests of the city, and includes more than 30 types of green spaces.
- Druzhba Square. This is a cozy place with wide alleys, which include both ordinary trees and exotic ones.
- Veretenivskyi Park. There are many trees here that are more than 100 years old, there is also a healing spring, and many wild animals have found refuge in the park.
- Taras Shevchenko Square. You can often meet elderly people playing chess, young people just walking around, and children feeding the permanent residents of the park, a great place to relax.

Ternopil. It has a city area of 86 km² and a population of -225,000 people. The calculated area of green areas in the city is 8.9 km², which is 39.56 m² of green space per capita.

Parks and squares play a significant role in creating green spaces for the use of the local population and visitors [3]. Some of the largest and most popular green spaces include:

- Park Zdorovye. One of the youngest parks in Ternopil, founded in 2000, it has only one main alley with 6 smaller ones branching off.
- Savych Park. Pupils of the Extreme Sports School train there. The ski season lasts, depending on weather conditions, from December to March.
- Old Park. It is the oldest park in Ternopil, has a large number of green spaces, and is therefore popular with locals and visitors.
- Kobzar Square. This is a cozy place in the heart of Ternopil where you can enjoy the natural tranquility and walk among the greenery.

Uzhhorod. As of 2023, the city's territory is 60 km², and the city's population is -115,400 people. The calculated area of green spaces in Uzhhorod is 15.7 km², which accounts for 136.05 m² of green space per capita.

There are many large parks and squares in Uzhhorod that serve as green spaces for the local population and visitors. Some of the largest and most popular green spaces include [45]:

- Bozdosh Park. There are equipped picnic areas and a spring with delicious mineral water. A large part of the territory goes to the river bank.
- Pidzamkovy Park. It has a surprisingly rich history, dating back to the 16th century, and is a great place for residents and tourists to relax.
- Loudon Arboretum. It is located within the city limits and is now one of the most attractive and prominent landmarks in the city.
- T. G. Masaryk Park. The park itself belongs to the nature reserve fund, with more than 20 species of trees of various origins, including those over 60

years old.

Vinnytsia has an area of 113 km^2 and a population of 369.7 thousand people. The calculated area of the city's green zones is 1.55 km^2, which is 4.19 m^2 of green space per capita (Table 1).

The green index in each district of the city is:

- Central district 6.64 m^2/person, which is formed by such areas as Leontovych Central Park, the Botanical Garden of Vinnytsia State Agrarian University, Vinnytsia Forest Park);
- Zamostianskyi district 0.44 m^2/person - green areas of the Park Khimikiv and the Park Zelena Poliana;
- Starohradskyi district 4.02 m^2/person (Sabarovskyi Park; Ancient Park; Vyshnevyi Park) [28].

Zaporizhzhia. It covers an area of 334 km² and has a population of -710,100 people. The calculated area of green areas in Zaporizhzhia is 5.0 km², which accounts for 7.0 m² of green space per capita.

Among the largest and most recognizable green areas in the city are the following [31]:

- Oak Grove Park. The central park of culture and recreation of the city. It is one of the most environmentally friendly places, especially crowded on weekends.
- Shevchenko Park. It is a wonderful green place for recreation, has a fairly large territory, a large number of places where residents can relax.
-Victory Park. It is considered the largest park in the city and attracts visitors with its cultural sites and historical monuments.
- Voznesenivskyi Park. It has an incredible combination of hills, well-groomed paths, picturesque flower arrangements and lakes, and every year it hosts large-scale fairs.

The city of ***Zhytomyr*** has an area of 65 km² and a population of 261600 people. The area of green areas of the city is 2.29 km², which is 8.75 m² of green space per capita (Table 1).

The green index in the city districts is:

- Bohunsky district 7.06 m^2/person (Kroshensky Square; Botanical Garden of Zhytomyr National Agroecological University; Park of Glory; Park of the Thirtieth Anniversary of Victory);
- Korolevskyi district 10.96 m^2/person (Lyatoshynskyi Square; Park of Culture and Recreation “Renaissance”; Smokovskyi Park; Korbutovskyi Hydropark) [30].

In general, the average indicator of housing provision for the population of Ukraine's regional centres was calculated to be 16 m^2 per capita (Table 1), which is significantly lower than the European norm. This indicates insufficient work in this area by municipal services. When planning the development of green infrastructure in cities, it should be understood that the formation of green areas is influenced by the ratio of built-up and open urban areas. Other important factors in the formation of green areas are the natural features of the areas in each city: climate, relief, vegetation, soil fertility, water bodies, as well as temperature and wind conditions, wind speed, precipitation, etc. At the same time, some cities that have more favourable conditions for vegetation development, as evidenced by the indicator of total forest cover in the region (Fig. 2), do not use the natural potential and do not develop green spaces. We are talking primarily about Chernivtsi, Zhytomyr, Ivano-Frankivsk, where the green space is much lower than the recommended European norm of 20 m^2 per person. As for such steppe cities as Kropyvnytskyi and Donetsk, their green space is even higher than the European norm.

The degree of influence of various factors on each case of greening may differ. Special attention is given to the comprehensive assessment of the state of the natural environment. In today’s world, free spaces in Ukrainian cities are increasingly occupied by new buildings, but along with this, the need for park areas is also growing. Every week, the urban population continues to grow, while green spaces remain unchanged. As the population increases, so does the need for green areas for recreation, sports, leisure, and maintaining ecological balance.

Strengthening green infrastructure strategies in Ukrainian cities is a key aspect of sustainable development, improving the quality of life, and reducing environmental impact. Specific recommendations for the effective implementation of such a strategy include:

Analysis and zoning:

- Conduct a detailed analysis of the city's environmental condition, identifying areas with the highest levels of pollution and the lowest levels of greenery.
- Develop a zoning plan to identify locations where the enhancement of green infrastructure is most needed.

Creation of new green areas:

- Launch programs to create new parks, squares, and forest parks, especially in parts of the city lacking green spaces.
- Ensure accessibility of new green areas for various population groups and adapt them to the needs of people with disabilities.

Ecological architecture and landscaping:

- Promote green technologies and energy efficiency standards in both new and existing buildings.
- Implement green roofs, green facades, and eco-friendly parking solutions.

Development of urban gardens and vegetable plots:

- Launch initiatives to develop community gardens and urban farms, which not only provide food but also support biodiversity and enhance the urban landscape.

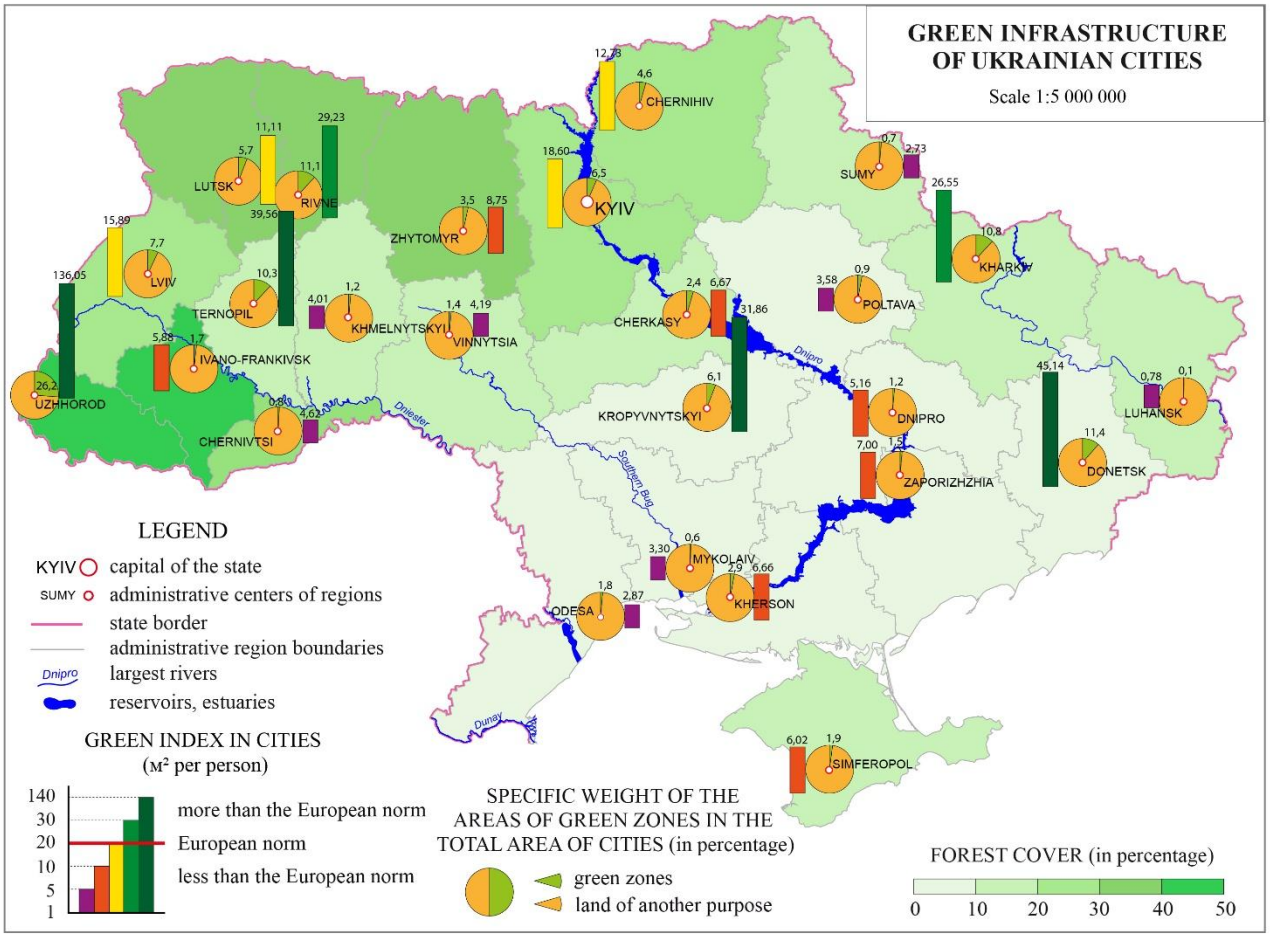

Fig. 2. Green infrastructure of Ukrainian cities

Bicycle and pedestrian routes:

- Develop and expand existing networks of bicycle and pedestrian paths, promoting reduced car usage and improved urban mobility.
- Ensure safe crossings, such as green bridges.

Support for innovation and technology:

- Use information technologies to monitor the state of green infrastructure and improve its management.
- Engage startups and tech companies in developing innovative solutions for green infrastructure.

Community involvement:

- Support and encourage public participation in decision-making on green infrastructure development.
- Organize community events, volunteer programs, and educational initiatives to foster environmentally conscious behavior among citizens.

Awareness and education:

- Conduct awareness campaigns and educational events highlighting the benefits of green infrastructure.
- Create public information resources providing access to data on the condition and development of the city's green zones.
- These recommendations should serve as a foundation for developing targeted strategies for the implementation of green infrastructure in Ukrainian cities, taking into account their specific features and needs.

Conclusions. Overall, the comparison of green spaces in different cities showed that there is considerable variation in their number and location. Given the importance of green spaces for the health and well-being of the population, further development and maintenance of green spaces is essential to improve the quality of life in cities. Green spaces in cities play an important role in improving the quality of life of residents. They provide recreational areas, improve air quality, and reduce noise and stress. Green spaces also contribute to the physical and psychological health of the population. Given the importance of green spaces for urban livability, it is important to pay attention to preserving and expanding such spaces in cities. This can include preserving existing parks, gardens and forests, creating new green spaces and integrating green elements into urban planning.

The geographical analysis based on geodata and indices allowed us to assess the state of green areas

in cities, identify the lack of green areas, and decide on the necessary measures to increase and improve green space.

1. The provision of green infrastructure in Ukrainian cities does not depend on natural areas or the overall leafiness of the region. The main factor in the development of urban green infrastructure is the work of local utility organisations.

2. According to the results of the analysis, the cities with the best green infrastructure are Uzhhorod, Donetsk, Ternopil, Kropyvnytskyi, Rivne and Kharkiv, where the green indices are 136, 45, 39, 31, 29 26. This indicates that cities are actively working to preserve green areas and create comfortable environmental conditions for residents.

3. On the other hand, in cities such as Luhansk (0.78), Sumy (2.73), Odesa (2.87), Mykolaiv (3.3), and Poltava (3.58), the area of green areas reaches catastrophic levels. They are more than 5 times behind the average European standards.

The overall conclusion is that the state of green infrastructure in Ukrainian cities is diverse and requires attention at different levels. Cities that are leading the way in creating and maintaining green spaces show that it is possible and contribute to improving the quality of life of their residents. At the same time, cities with an insufficient amount of green space lag behind the standards, which can have a negative impact on health and the overall state of the urban environment.

For the development of green infrastructure in cities, it is advisable to use both the experience of Ukrainian and European cities [3, 51], where various options are successfully implemented in view of the possibility of renewing the existing urban space.

Bibliography

1. *Lu, J., Ren, L.,Zhang, C., Liang, M., Stasiulis, N., & Streimikis, J. (2020). Impacts of feminist ethics and gender on the implementation of CSR initiatives. Filosofija-Sociologija, 31(1), 24–33.*
2. *Федонюк, М. А., Прохоренко, А. Ю., Федонюк, В. В. (2018). Дослідження формування та просторового розподілу «острова тепла» над Луцьком. Екологічні нотатки, 6, 45-53.*
3. *Зелено-блакитна інфраструктура в містах пострадянського простору: вивчення спадщини та підключення до досвіду країн V4 : колективна монографія. – Харків : ХНУ імені В. Н. Каразіна, 2022. – 400 с. https://ekhnuir.karazin.ua/handle/123456789/18778*
4. *Apostolopoulou, E., & Adams, W. M. (2015). Neoliberal capitalism and conservation in the post-crisis era: The dialectics of "green" and "un-green" grabbing in Greece and the UK. Antipode, 47(1), 15–35. https://doi.org/10.1111/anti.12102*
5. *Цілі сталого розвитку. (б. д.). UNDP. https://www.undp.org/uk/ukraine/tsili-staloho-rozvytku*
6. *Максименко, Н. В., Бурченко, С. В. (2019). Теоретичні основи стратегії зеленої інфраструктури: міжнародний досвід. Людина та довкілля. Проблеми неоекології , 31 (31), 16-25. https://doi.org/10.26565/1992-4224-2019-31-02*
7. *Jun Ying, Xiaojing Zhang, Yiqi Zhang & Svitlana Bilan (2022) Green infrastructure: systematic literature review, Economic Research-Ekonomska Istraživanja, 35:1, 343-366, DOI: https://doi.org/10.1080/1331677X.2021.1893202*
8. *Lovell, S.T., Taylor, J.R. (2013). Supplying urban ecosystem services through multifunctional green infrastructure in the United States. Landscape Ecol, 28, 1447–1463 https://doi.org/10.1007/s10980-013-9912-y*
9. *Naumann, S.; Davis, M.; Kaphengst, T.; Pieterse, M.; Rayment, M. Design, Implementation and Cost Elements of Green Infrastructure Projects; European Commission: Brussels, Belgium, 2011*
10. *Green Infrastructure (GI) – Enhancing Europe's Natural Capital. (2013). European Commission: Brussels, Belgium.*
11. *Green Infrastructure Guidance. Natural England, Sheffield (2009). URL: https://water.rutgers.edu/Green_Infrastructure_Guidance_Manual/2016-08-10_REV1*
12. *Hoover, F.-A., Meerow, S., Coleman, E., Grabowski, Z., & McPhearson, T. (2023). Why go green? Comparing rationales and planning criteria for green infrastructure in U.S. city plans. Landscape and Urban Planning, 237, 104781. https://doi.org/10.1016/j.landurbplan.2023.104781*
13. *Anguelovski, I., Connolly, J. J., Garcia-Lamarca, M., Cole, H., & Pearsall, H. (2019). New scholarly pathways on green gentrification: What does the urban 'green turn' mean and where is it going? Progress in Human Geography, 43(6), 1064-1086. https://doi.org/10.1177/0309132518803799*
14. *Liu, H., Kong, F., Yin, H., Middel, A., Zheng, X., Huang, J., Xu, H., Wang, D., & Wen, Z. (2021c). Impacts of green roofs on water, temperature, and air quality: A bibliometric review. Building and Environment, 196, 107794. https://doi.org/10.1016/j.buildenv.2021.107794*
15. *Hrechko, A. A. (2022). Experience and benefits of using green roofs as an element in green infrastructure. Visnyk of V. N. Karazin Kharkiv National University Series «Ecology», (26), 32–42. https://doi.org/10.26565/1992-4259-2022-26-03*
16. *Maksymenko, N., Burchenko, S., Hrechko, A. & Sonko, S. (2023). Carbon sequestration and provision of green infrastructure in the Ukrainian cities of Kharkiv and Chuguiv in the context of post-war reconstruction. Acta Horticulturae et Regiotecturae, 26, 2, 90-98. https://doi.org/10.2478/ahr-2023-0013*
17. *The 5 Principles of Green Economy. (б. д.). Green Economy Coalition. https://www.greeneconomycoalition.org/news-and-resources/the-5-principles-of-green-economy*

18. Communication from the commission to the European Parliamen. The European Green Deal. Brussels, 11.12.2019.COM/2019/640. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0640
19. Ачасова А. О. та Ачасов А. Б. (2024). Європейська зелена угода та перспективи для України. Людина та довкілля. Проблеми неоекології, (41), 33-56. https://doi.org/10.26565/1992-4224-2024-41-03
20. Jayasooriya, V.M., Ng, A.W.M. (2014). Tools for Modeling of Stormwater Management and Economics of Green Infrastructure Practices: a Review. Water Air Soil Pollut 225, 2055 https://doi.org/10.1007/s11270-014-2055-1
21. Гречко, А. А., Максименко, Н. В., Шкаруба, А. Д., & Кутузов, Є. О. (2024). Біорізноманіття рослин приміських луків для створення міських газонів з польовими квітами. Людина та довкілля. Проблеми неоекології, (41), 100-111. https://doi.org/10.26565/1992-4224-2024-41-07
22. Rietz, A. (2023). Wildlife-vehicle collisions : An evaluation of the mitigation effect by ecoducts and fauna bridges in Sweden (Dissertation). Retrieved from https://urn.kb.se/resolve?urn=urn:nbn:se:umu:diva-210874
23. Afaq, H., Chambers, D.N., Zolnikov, T.R. (2022). Urban Heat Islands. In: Brears, R.C. (eds) The Palgrave Encyclopedia of Urban and Regional Futures. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-87745-3_339
24. Кицюк, І., Науменко, Н., & Присяжнюк, В. (2023). Європейський зелений курс: можливості та наслідки для українського бізнесу. Економіка та суспільство, (56). https://doi.org/10.32782/2524-0072/2023-56-87
25. Картографічний сервіс Google- Планета Земля. URL: https://earth.google.com/web/
26. Чисельність населення по містах України. Мінфін. URL : https://index.minfin.com.ua/ua/reference/people/town/
27. Міста України за площею. INSIDE-UA. URL : https://inside-ua.com/cities/by-area
28. Зелені зони Вінниці. Our-Travel.info. URL: https://our-travels.info/ost/Goroda/Ukraine/Vinnica/Vinnica-park.php.
29. Дніпровська міська рада. URL: https://dniprorada.gov.ua/uk/articles/item/38637/u-dnipri-stvorili-mapu-zdorovogo-ta-bezpechnogo-vidpochinku
30. Парки культури та відпочинку у Житомирі. zt.locator.ua. URL: https://zt.locator.ua/zhytomyr/parky/ru/.
31. Парки Запоріжжя. URL: https://zaporizhzhia.city/news/parki-zaporizza#
32. Парки та сквери Івано - Франківська. URL: https://typical.if.ua/parky-ta-skvery-ivano-frankivska-foto
33. УНІАН Інформаційне Агенство. Найкращі парки Києва. URL: https://www.unian.ua/tourism/lifehacking/naykrashchi-parki-kiyeva-2020-spisok-parkiv-kiyeva-z-foto-novini-kiyeva-10991135.html
34. Екополітика. Екологічна стратегія Києва 2030. URL: https://ecopolitic.com.ua/ua/news/kiivrada-vpershe-zatverdila-ekologichnustrategiju-mista-do-2030-roku/
35. Сквери та парки: 10 місць, де можна сховатися від спеки в Кропивницькому. URL: https://dostyp.com.ua/novini/skvieri-ta-parki-10-mists-die-mozhna-skhovatisia-vid-spieki-v-kropivnits-komu-foto/
36. Парки Луганська. URL: https://lugansk.wiki/places/parki/
37. Скільки в Луцьку зелених зон: перелік. URL: https://konkurent.ua/publication/14969/skilki-v-lucku-zelenih-zon-perelik
38. Maksymenko N., Shpakivska I., Burchenko S., Utkina K. Green Infrastructure in Lviv - example of park zones / Acta Horticulturae et Regiotecturae. Slovak University of Agriculture in Nitra. 25, 2022(1): 37–43. https://doi.org/10.2478/ahr-2022-0005
39. Зелена інфраструктура Миколаїва. IGo.World.com. URL: https://ua.igotoworld.com/ua/poi_catalog/399136-134-parks-gardens-mykolaiv.htm#google_vignette.
40. Одеська міська рада. URL: https://omr.gov.ua/ru/acts/council/22345/
41. Інтернет- видання Полтавщина. URL: https://poltava.to/news/64809/
42. Рівне Медіа. URL: https://rivne.media/news/shcho-podivitisya-u-rivnomu-top10-tsikavikh-mists-dlya-znayomstva-z-mistom-44148
43. Парки культури та відпочинку у Сімферополі. Bebeshka. URL: https://cr.bebeshka.info/simferopol/parki-kultury-i-otdyha/
44. Парки та сквери міста Суми. Visit.Sumy. URL: https://visit.sumy.ua/parki-i-skveri/
45. Туризм Закарпаття. URL: https://tourinform.org.ua/parky-ta-skvery-uzhgorodskogo-rajonu
46. Парки та сади Херсону. IGo.World.com. URL: https://ua.igotoworld.com/ru/poi_catalog/391215-134-parks-gardens-kherson.htm
47. Зелені зони міста Хмельницький. Our-Travel.info. URL: https://our-travels.info/ost/Goroda/Ukraine/Hmelnitski/Hmelnitski-park.php?ysclid=lj77i81ipw344211202
48. Черкаська обласна державна адміністрація. URL: https://ck-oda.gov.ua/novyny-cherkaskoyi-oblasti/na-cherkashhini-vidkrili-23-aktivni-parki/
49. Зелені насадження Чернівців. Парки та сквери. Chernivtsi Online. URL: https://chernivtsi-online.net/places/sights/parks/
50. Природні зони Чернігова. nationalparks.in.ua. URL: https://www.nationalparks.in.ua/pryrodni-parky/chernigiv/
51. Maksymenko N. V., Bihuňová M Green innovations in urban landscape: opportunities to use Slovakia's experience. Людина та довкілля. Проблеми неоекології. 2024. Вип. 42. С. 95-112. DOI: https://doi.org/10.26565/1992-4224-2024-42-07

Authors Contribution: All authors have contributed equally to this work
Conflict of Interest: The authors declare no conflict of interest

References

1. *Lu, J., Ren, L.,Zhang, C., Liang, M., Stasiulis, N., & Streimikis, J. (2020). Impacts of feminist ethics and gender on the implementation of CSR initiatives. Filosofija-Sociologija, 31(1), 24–33.*
2. *Fedoniuk, M. A., Prokhorenko, A. Y., Fedoniuk, V. V. (2018). Study of the formation and spatial distribution of the "heat island" over Lutsk. Ecological Notes, 6, 45-53. [in Ukrainian]*
3. *Green & Blue infrastructure in post-USSR cities: exploring legacies and connecting to V4 experience: collective monograph. Ed. by N.V. Maksymenko, A.D. Shkaruba (2022). Kharkiv: V. N. Karazin Kharkiv National University, 400. https://ekhnuir.karazin.ua/handle/123456789/18778 [in Ukrainian]*
4. *Apostolopoulou, E., & Adams, W. M. (2015). Neoliberal capitalism and conservation in the post-crisis era: The dialectics of "green" and "un-green" grabbing in Greece and the UK. Antipode, 47(1), 15–35. https://doi.org/10.1111/anti.12102*
5. *What are the Sustainable Development Goals?UNDP. https://www.undp.org/ukraine/sustainable-development-goals*
6. *Maksymenko, N. V., & Burchenko, S. V. (2019). Theoretical Basis of the Green Infrastructure Strategy: International Experience. Man and Environment. Issues of Neoecology, 31(31), 16-25. https://doi.org/10.26565/1992-4224-2019-31-02 [in Ukrainian]*
7. *Jun Ying, Xiaojing Zhang, Yiqi Zhang & Svitlana Bilan (2022). Green infrastructure: systematic literature review, Economic Research-Ekonomska Istraživanja, 35:1, 343-366, DOI: https://doi.org/10.1080/1331677X.2021.1893202*
8. *Lovell, S.T., Taylor, J.R. (2013). Supplying urban ecosystem services through multifunctional green infrastructure in the United States. Landscape Ecol, 28, 1447–1463 https://doi.org/10.1007/s10980-013-9912-y*
9. *Naumann, S.; Davis, M.; Kaphengst, T.; Pieterse, M.; Rayment, M. (2011). Design, Implementation and Cost Elements of Green Infrastructure Projects; European Commission: Brussels, Belgium.*
10. *Green Infrastructure (GI) –Enhancing Europe's Natural Capital. (2013). European Commission: Brussels, Belgium.*
11. *Green Infrastructure Guidance. Natural England, Sheffield (2009). URL: https://water.rut-gers.edu/Green_Infrastructure_Guidance_Manual/2016-08-10_REV1*
12. *Hoover, F.-A., Meerow, S., Coleman, E., Grabowski, Z., & McPhearson, T. (2023). Why go green? Comparing rationales and planning criteria for green infrastructure in U.S. city plans. Landscape and Urban Planning, 237, 104781. https://doi.org/10.1016/j.landurbplan.2023.104781*
13. *Anguelovski, I., Connolly, J. J., Garcia-Lamarca, M., Cole, H., & Pearsall, H. (2019). New scholarly pathways on green gentrification: What does the urban 'green turn' mean and where is it going? Progress in Human Geography, 43(6), 1064-1086. https://doi.org/10.1177/0309132518803799*
14. *Liu, H., Kong, F., Yin, H., Middel, A., Zheng, X., Huang, J., Xu, H., Wang, D., & Wen, Z. (2021c). Impacts of green roofs on water, temperature, and air quality: A bibliometric review. Building and Environment, 196, 107794. https://doi.org/10.1016/j.buildenv.2021.107794*
15. *Hrechko, A. A. (2022). Experience and benefits of using green roofs as an element in green infrastructure. Visnyk of V. N. Karazin Kharkiv National University Series «Ecology», (26), 32–42. https://doi.org/10.26565/1992-4259-2022-26-03*
16. *Maksymenko, N., Burchenko, S., Hrechko, A. & Sonko, S. (2023). Carbon sequestration and provision of green infrastructure in the Ukrainian cities of Kharkiv and Chuguiv in the context of post-war reconstruction. Acta Horticulturae et Regiotecturae, 26, 2, 90-98. https://doi.org/10.2478/ahr-2023-0013*
17. *The 5 Principles of Green Economy. Green Economy Coalition. https://www.greeneconomycoalition.org/news-and-resources/the-5-principles-of-green-economy*
18. *Communication from the commission to the European Parliamen. The European Green Deal. Brussels, 11.12.2019.COM/2019/640. URL: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52019DC0640*
19. *Achasova, A. O., & Achasov, A. B. (2024). The European Green Deal and prospects for Ukraine. Man and Environment. Issues of Neoecology, (41), 33-56. https://doi.org/10.26565/1992-4224-2024-41-03 [in Ukrainian]*
20. *Jayasooriya, V.M., Ng, A.W.M. (2014). Tools for Modeling of Stormwater Management and Economics of Green Infrastructure Practices: a Review. Water Air Soil Pollut 225, 2055 https://doi.org/10.1007/s11270-014-2055-1*
21. *Hrechko, A. A., Maksymenko, N. V., Shkaruba, A. D., & Kutuzov, Y. O. (2024). Biodiversity of plants in suburban meadows to create urban lawns with wildflowers. Man and Environment. Issues of Neoecology, (41), 100-111. https://doi.org/10.26565/1992-4224-2024-41-07 [in Ukrainian]*
22. *Rietz, A. (2023). Wildlife-vehicle collisions : An evaluation of the mitigation effect by ecoducts and fauna bridges in Sweden (Dissertation). Retrieved from: https://urn.kb.se/resolve?urn=urn:nbn:se:umu:diva-210874*
23. *Afaq, H., Chambers, D.N., Zolnikov, T.R. (2022). Urban Heat Islands. In: Brears, R.C. (eds) The Palgrave Encyclopedia of Urban and Regional Futures. Palgrave Macmillan, Cham. https://doi.org/10.1007/978-3-030-87745-3_339*
24. *Kytsyuk, I., Naumenko, N., & Prysiazhniuk, V. (2023). European Green Deal: Opportunities and Consequences for Ukrainian Business. Economy and Society, (56). https://doi.org/10.32782/2524-0072/2023-56-87 [in Ukrainian]*
25. *Google Earth mapping service. URL: https://earth.google.com/web/*
26. *Population by city in Ukraine. Ministry of Finance. URL: https://index.minfin.com.ua/ua/reference/people/town/ [in Ukrainian]*
27. *Ukrainian cities by area. INSIDE-UA. URL: https://inside-ua.com/cities/by-area [in Ukrainian]*
28. *Green areas of Vinnytsia. Our-Travel.info. URL: https://our-travels.info/ost/Goroda/Ukraine/Vinnica/Vinnica-park.php [in Ukrainian]*

29. *Dnipro City Council. URL: https://dniprorada.gov.ua/uk/articles/item/38637/u-dnipri-stvorili-mapu-zdorovogo-ta-bezpechnogo-vidpochinku [in Ukrainian]*
30. *Parks of culture and recreation in Zhytomyr. zt.locator.ua. URL: https://zt.locator.ua/zhytomyr/parky/ru/ [in Ukrainian]*
31. *Zaporizhzhia parks. URL: https://zaporizhzhia.city/news/parki-zaporizza# [in Ukrainian]*
32. *Parks and squares of Ivano-Frankivsk. URL: https://typical.if.ua/parky-ta-skvery-ivano-frankivska-foto [in Ukrainian]*
33. *UNIAN Information Agency. The best parks in Kyiv. URL: https://www.unian.ua/tourism/lifehacking/naykrashchi-parki-kiyeva-2020-spisok-parkiv-kiyeva-z-foto-novini-kiyeva-10991135.html [in Ukrainian]*
34. *Environmental policy. Kyiv Environmental Strategy 2030. URL: https://ecopolitic.com.ua/ua/news/kiivrada-vpershe-zatverdila-ekologichnustrategiju-mista-do-2030-roku/ [in Ukrainian]*
35. *Squares and parks: 10 places to hide from the heat in Kropyvnytskyi. URL: https://dostyp.com.ua/novini/skvieri-ta-parki-10-mists-die-mozhna-skhovatisia-vid-spieki-v-kropivnits-komu-foto/ [in Ukrainian]*
36. *Parks of Luhansk. URL: https://lugansk.wiki/places/parki/ [in Ukrainian]*
37. *How many green areas are there in Lutsk: a list. URL: https://konkurent.ua/publication/14969/skilki-v-lucku-zelenih-zon-perelik-/ [in Ukrainian]*
38. *Maksymenko N., Shpakivska I., Burchenko S., Utkina K. Green Infrastructure in Lviv - example of park zones / Acta Horticulturae et Regiotecturae. Slovak University of Agriculture in Nitra. 25, 2022(1): 37–43. https://doi.org/10.2478/ahr-2022-0005*
39. *Green infrastructure in Mykolaiv. IGo.World.com. URL: https://ua.igotoworld.com/ua/poi_catalog/399136-134-parks-gardens-mykolaiv.htm#google_vignette [in Ukrainian]*
40. *Odesa City Council. URL: https://omr.gov.ua/ru/acts/council/22345/ [in Ukrainian]*
41. *Online publication Poltavshchyna. URL: https://poltava.to/news/64809/ [in Ukrainian]*
42. *Rivne Media. URL: https://rivne.media/news/shcho-podivitisya-u-rivnomu-top10-tsikavikh-mists-dlya-znayomstva-z-mistom-44148 [in Ukrainian]*
43. *Parks of culture and recreation in Simferopol. Bebeshka. URL: https://cr.bebeshka.info/simferopol/parki-kultury-i-otdyha/ [in Ukrainian]*
44. *Parks and squares of the city of Sumy. Visit.Sumy. URL: https://visit.sumy.ua/parki-i-skveri/ [in Ukrainian]*
45. *Tourism in Transcarpathia. URL: https://tourinform.org.ua/parky-ta-skvery-uzhgorodskogo-rajonu [in Ukrainian]*
46. *Parks and gardens of Kherson. IGo.World.com. URL: https://ua.igotoworld.com/ru/poi_catalog/391215-134-parks-gardens-kherson.htm [in Ukrainian]*
47. *Green areas of Khmelnytskyi city. Our-Travel.info. URL: https://our-travels.info/ost/Goroda/Ukraine/Hmelnitski/Hmelnitski-park.php?ysclid=lj77i81ipw344211202 [in Ukrainian]*
48. *Cherkasy Regional State Administration. URL: https://ck-oda.gov.ua/novyny-cherkaskoyi-oblasti/na-cherkashhini-vidkrili-23-aktivni-parki/ [in Ukrainian]*
49. *Green spaces in Chernivtsi. Parks and squares. Chernivtsi Online. URL: https://chernivtsi-online.net/places/sights/parks/ [in Ukrainian]*
50. *Natural zones of Chernihiv. nationalparks.in.ua. URL: https://www.nationalparks.in.ua/pryrodni-parky/chernigiv/ [in Ukrainian]*
51. *Maksymenko, N. V., & Bihuňová, M. (2024). Green innovations in urban landscape: opportunities to use Slovakia's experience. Man and Environment. Issues of Neoecology, (42), 95-112. https://doi.org/10.26565/1992-4224-2024-42-07*

Зелена інфраструктура міст України в контексті Європейського зеленого курсу

Надія Максименко [1]
д. геогр. н., професор, завідувач кафедри екологічного моніторингу та заповідної справи,
[1] Харківський національний університет імені В.Н. Каразіна, Харків, Україна;
Віліна Пересадько [1]
д. геогр. н., професор, кафедра фізичної географії та картографії;
Аліна Гречко [1]
викладач кафедри екологічного моніторингу та заповідної справи;
Світлана Бурченко [1]
д. філософії (Науки про Землю), доцент кафедри екологічного моніторингу та заповідної справи;
Анна Скриган [2]
к. геогр. н., доцент з екології;
[2] Erda Research, Technology, Education; Гаага, Нідерланди

Зростання урбанізації, зміни клімату та екологічні виклики підкреслюють важливість порівняльної оцінки забезпеченості зеленою інфраструктурою міст України для покращення якості міського середовища та життя громадян. Проведення порівняльної оцінки забезпеченості зеленою інфраструктурою обласних центрів України дозволить виявити рівень розвитку зелених зон у кожному місті, визначити їхні поточні проблеми та потенціал для

подальшого розвитку. Такий аналіз надасть можливість місцевим органам влади та розробникам політик вжити необхідних заходів для поліпшення стану зеленої інфраструктури та збільшення її доступності для всіх жителів міст. Мета статті – визначити особливості формування та функціонування зеленої інфраструктури (ЗІ) в містах-обласних центрах України, порівняти забезпеченість населення зеленими зонами у різних адміністративних одиницях цих міст. Для отримання статистичної інформації про населення кожного району міста та площу окремих зелених ділянок був використаний метод статистичного аналізу та дешифрування матеріалів дистанційного зондування. Для цього використовувались супутникові знімки з картографічного сервісу Google- Планета Земля. Математичні обчислення проводилися відповідно до методики розрахунку загальноприйнятого Зеленого індексу, що визначався як співвідношення між площею району (міста) та кількістю його мешканців. Створено банк даних щодо площі зелених зон в містах України. Розраховано зелені індекси по районах кожного міста та зроблено аналіз складових зелених зон в кожному з районів. Створено картографічні моделі просторового розподілу зеленої інфраструктури по обласних центрах на тлі природної лісистості територій. Зроблено порівняння забезпеченості міст України зеленою інфраструктурою та визначено шляхи покращення ситуації. В цьому дослідження вперше узагальнено матеріал по всіх обласних центрах України стосовно забезпеченості населення зеленою інфраструктурою, обраховано зелені індекси, проведено просторовий аналіз та розроблено відповідні рекомендації.

***Ключові слова**: Зелена інфраструктура, Зелений індекс, райони, зелені зони, зелені коридори, міський ландшафт, Європейський зелений курс, картографічна модель.*

Внесок авторів: всі автори зробили рівний внесок у цю роботу
Конфлікт інтересів: автори повідомляють про відсутність конфлікту інтересів

Надійшла 24 березня 2025 р.
Прийнята 9 травня 2025 р.