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Assessing the level of greening in a major city: subjective and objective evaluation on the example of the city of Kyiv

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Abstract. One of the ways to ensure the sustainable development of settlements is to improve comfort of living in urban areas. The formation of a developed landscaping system is one of the priorities of modern city development and provides an opportunity to realise the main functions of green areas of public use – ecological, historical, cultural, urban and social. Sufficiency or insufficiency of green areas is determined by indicators both objective (the level or area of landscaping per person), and subjective (the feeling of green space and comfort of urban areas). This study addresses both of these aspects. Significant differences in the findings of sociological surveys conducted earlier were also analysed. Residents of the city of Kyiv completed a questionnaire, which evaluated not only the existing greening system of the city, but also the perceived priority directions for its improvement. Four main criteria for assessing the quality of landscaping elements are proposed – environmental friendliness, contact, accessibility and attractiveness.

Contents:

1. Introduction

The awareness of the need for urgent measures to safeguard the wealth and resources of the world is reflected in the concept of the sustainable development of mankind. One of the key components of this development is environmental. In particular, Goal 15 of the 2030 Agenda for Sustainable Development determines the need to "Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss".

The solution of this goal should be facilitated by the formation of an ecological network at various hierarchical levels as "a single territorial system that includes areas of natural landscapes, territories and objects of a nature reserve fund [...]" (Law of Ukraine, 2000; Oleinichenko, 2011). The main structural elements of the ecological network at the national level are natural focuses, connecting territories (eco-corridors), buffer zones and restoration areas (Malyuga, Yukhnovsky, 2012). V. Malyuga and V. Yukhnovsky formulated the basic principles for the formation of a national ecological network that should prevent the natural environment being degraded by human activities. From among the determined principles (which include: the rational use of natural resources; pertinence, planning and consistency; and the application of environmental protection ideology[Malyuga, Yukhnovsky, 2012]) the anthropocentric principle should be distinguished. It is taken by the authors to be the determining principle, since it is directly related to both positive and negative human influences on the environment, and to the influence of the environment on man.

At the citywide level, the system of green areas and open water bodies of the city – forests, recreational forests, parks, squares and other elements of the green space system – act as the ecological network or ecological framework of the city (Shvets, Rudenko, Veremiy, 2010; Kryzhanovsky, Nagorna, 2014). It is in the cities that the most significant mutual influence of man and the natural environment is felt, due to the large concentration of populations, which globally is more than half of humanity, and in Ukraine is 69.4% (The United Nations Department of Economic and Social Affairs: Urban Population Index 2019).

The ecological function as the main function of urban green spaces has been widely studied by numerous scientists. This is due to the fact that green spaces: absorb carbon dioxide and release oxygen; reduce air temperature in hot weather by the evaporation of moisture; prevent strong overheating by protecting the soil and building wall surfaces from direct sunlight; reduce the level of urban noise; reduce dust and air pollution; and secrete volatiles that can kill pathogenic bacteria (Mashinsky, Zologina, 1978; Selmi et al., 2016).

Urban green spaces have a leading place in the architectural and planning structure of the city. They are involved in forming the main structural elements of the city. By creating gaps in continuous building areas, green spaces unite residential areas, giving the city integrity and completeness; they affect the visual characteristics of the urban environment, giving them a special atmosphere with a wealth of shapes and colours (Burgess et al., 1988).

Considering ecological and planning functions, forming a city's green framework is an important component of creating a widely developed greening system for the city in order to provide the most comfortable living conditions for the population.

According to the legislative and normative documentation of Ukraine, all green areas in cities and towns are divided, in accordance with their functions or purpose, into the following groups: *green spaces for public use*; *green spaces of restricted use*; *green spaces for special purposes* (Town planning, 2001; DBN B.2.2-12:2019, 2019).

However, it is green spaces for public use that are decisive in forming a sense of comfort in the urban environment (Swanwick et al., 2003).

The sufficiency of green spaces can be assessed according to two groups of characteristics – quantitative and qualitative. Previous studies have tended to use objective measures such as expert judgment or a geographic information system (Wan, Shen, 2015).

The most accurate method for determining the quantitative indicators of the area of urban green spaces is considered to be the use of GIS technologies to supplement databases of land and urban cadasters (Gupta et al., 2016; Trubina et al., 2017). GIS models allow not only the reliable recording of

quantitative indicators of the area of green spaces, but also constant monitoring of changes, thereby allowing trends to be determined alongside the consequences of transformations of green space systems (Van Herzele, Wiedemann, 2003).

GIS technologies can also be used in determining the quality of the formed ecological network of the city. So, on the basis of the "Panorama" GIS system developed by Y. Kryzhanovsky and A. Nagorna, a general ecological network scheme was created and the connectivity of the biocentric-network structure of the ecological network scheme was estimated for the city of Vinnitsa, Ukraine (Kryzhanovsky, Nagorna, 2014).

In order to assess green spaces suitability for various purposes in the settlement, quantitative indicators such as the norms of greening per inhabitant (DBN B.2.2-12: 2019, 2019; Rules for maintaining green space in settlements of Ukraine, 2006) and the level of greening of urban development (DBN B.2.2-5:2011, 2011) are used. The level of greening is the percentage ratio of the area of greened territories to the total area of a city, a unit of its administrative division or a separate functional territory. The amount of greening per inhabitant is the amount of landscaped area (m²) required to meet the needs for rest, as well as to improve living conditions.

The norms for greening levels in residential quarters and neighbourhoods vary depending on the buildings' mark-up and are measured in square metres per inhabitant. The value of this norm is determined depending on the size of the urban population, the type of greened areas and the climatic sub-district to which the city belongs. For example, for the city of Kyiv the standard of green spaces of public use is 16 m²/person (DBN B.2.2-12:2019, 2019). In different countries, the norms of both the greening system as a whole and its individual structural elements are quite different. For example, the normative area of green space of a city park per city inhabitant can vary from 5 m²/person (Ukraine, Russia) to 10–15 m²/person (Germany) and up to 8–25 m²/person (USA) (Pleshkanovska, Usova, 2014).

Creating a comfortable urban environment aims primarily to give city residents a sense of satisfaction with the architectural and artistic appearance of the urban space, its convenience and the eco-

logical state. The environment for people cannot be created without considering the opinions of people. That is why carrying out sociological research is a common method for substantiating urban design decisions, and a city ecological network design in particular (Burgess et al., 1988; Kweon, Sullivan, 1998).

Of course, the use of GIS technologies for monitoring and determining the status of residents' satisfaction with green spaces can provide more accurate quantitative indicators of areas of urban green spaces. However, even if there is a regulated and sufficient area of green space in the city, residents sometimes have a subjective sense of a lack of green areas. A subjective assessment of the level of city greening and the quality of urban green spaces is sometimes completely opposite.

The present paper analyses the reasons for this difference, as well as what influences the subjective perception of the extent to which city landscaping is adequate and provides comfort (in particular, on the example of the city of Kyiv).

2. Materials and research methods

2.1. Previous research methods for investigating greenery level in Kyiv

Many cities in the world call themselves "green cities". However, we need to distinguish between different definitions of this concept.

The traditional concept of a "green city" is based on a sufficiently high level of landscaping in the urban area and a developed system of green spaces. In the modern sense, a "green city" is one actively implementing such methods as: new forms of landscaping (vertical landscaping, landscaping of gardens, "hanging" gardens), green technologies in production aimed at reducing harmful emissions into reservoirs and air, or reforming transport infrastructure.

Kyiv is also often referred to as the "Green Capital" or "Chestnut City". According to a study by Philipp Gärtner, Kyiv is the greenest capital in Europe with a population of over two million (Gärtner, 2017). In their study, the authors applied the Nor-

malised Difference Vegetation Index (NDVI) method. This NDVI method is based on determining the types of points that are characterised by the presence or absence of living vegetation within a specific area. Using satellite imagery, the area around the official centres of 43 European cities with a diameter of five miles (about eight km) was analysed (see Fig. 1 for Kyiv).

According to the NDVI, Kyiv was ranked first in terms of live vegetation in the list of Europe's "greenest" cities with a population of over two million. Its index is 0.389 (the value of each capital index ranges from 0.0 to 0.5). In second place is Berlin with an index of 0.246. The London index is 0.135 and that of Moscow is 0.143. In last place according to the amount of vegetation among the capitals was Athens, with an index of 0.087 (Gärtner, 2017).

In 2009, analysts at The Economist Intelligence Unit commissioned by the German industrial giant Siemens tried to identify the "greenest city in Europe" (Taylor, 2009). The list includes 30 European capitals that were evaluated based on seven parameters: carbon dioxide emissions, energy, construction, transport, water resources, waste and land stock, air quality, and city management. The authors then recognised Copenhagen as the greenest, and Kyiv took last place – 30th – both in the overall list and in most of the individual parameters.

Thus, what is the actual level of landscaping in Kyiv?

Currently, the green areas of all kinds, in Kyiv amount to 45,449 ha or 54.4% of the total city area. Of these, the area of green spaces for public use is 5,115 ha. In total there are 127 parks in Kyiv, including six specialised, 367 squares and 77 boulevards (The Master Plan of Kyiv, 2015). The Master Plan of Kyiv envisages an increase in green spaces of general use to 7,400 ha, or from 18.5 m^2/person to 23.5 m^2/person (while the norm is defined at 16.0 m^2/person) (DBN B.2.2-12:2019, 2019). According to this, there is a sufficiently high level of landscaping and compliance with current regulatory requirements.

2.2. Research objective

Considering the abovementioned evidence, the question arises: how can we achieve an adequate
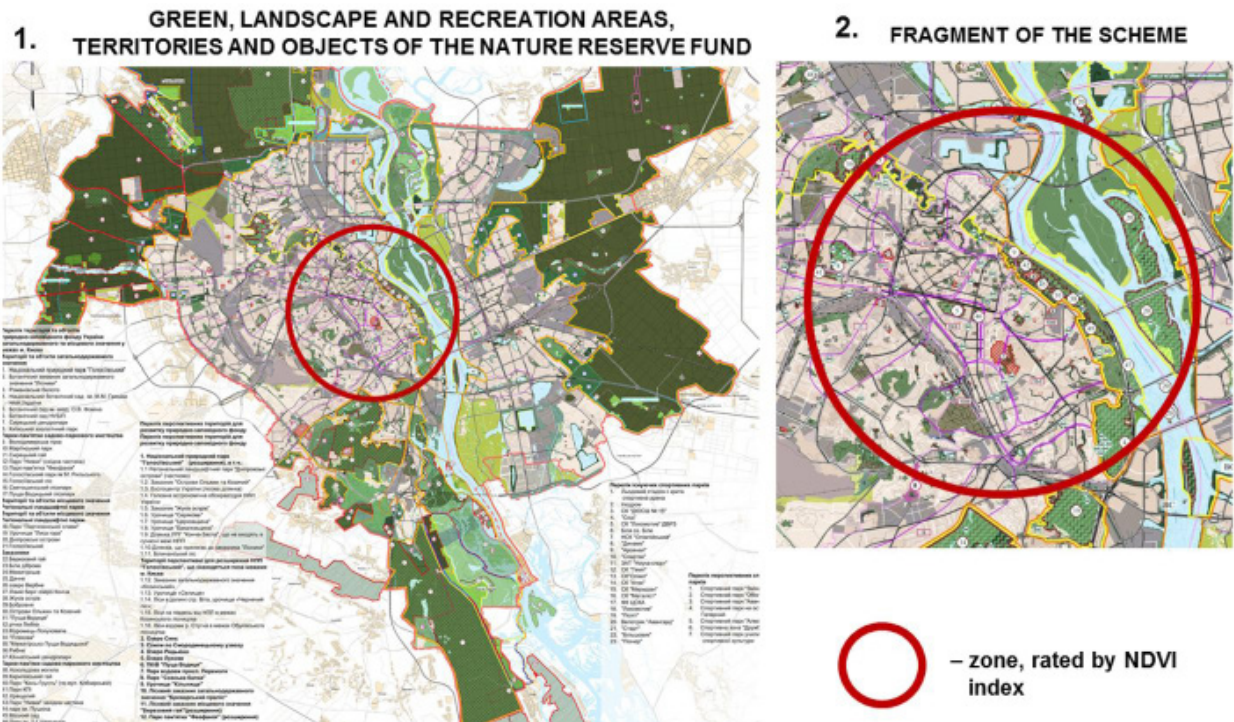

Fig. 1. Part of Kyiv territory considered in Gärtner

level of comfort of the urban environment, provided there is no possibility to create additional elements of the landscaping system within the already built up area?

For the past years a trend has been observed, where at the request of members of the Kyiv City Council or initiative groups of residents, individual green areas within a residential area have been granted status as "squares" (in essence, status as public-use green spaces is granted to previously restricted-use spaces). However, this does not really increase the area of greened spaces, but only changes the quantitative reporting. Giving status as a square to a small area within an existing residential area does not allow it to develop as an independent element of the public green space system – as a full-fledged park or square would. Such green spaces remain accessible only to a limited number of residents. The analysis of green space provision and its comparison with European cities shows, in general, the abundance of green spaces in the city of Kyiv, but their territorial location causes some discontent among citizens and leads to a feeling of the greenery being inadequate.

One way to solve this problem might be to increase the accessibility and attractiveness of existing elements of the city's greening system. For a more complete understanding of the needs of the population in the exercise of their recreational functions, this sociological study was conducted. Its purpose is to evaluate the attitudes of the population to the established greening system of the city of Kyiv and to determine priorities for improving the level of attractiveness and comfort of parks and squares for city inhabitants.

The functional landscaping elements selected for the study are multi-functional landscaped public areas. Their location in the planning structure of the city is shown in Fig. 2.
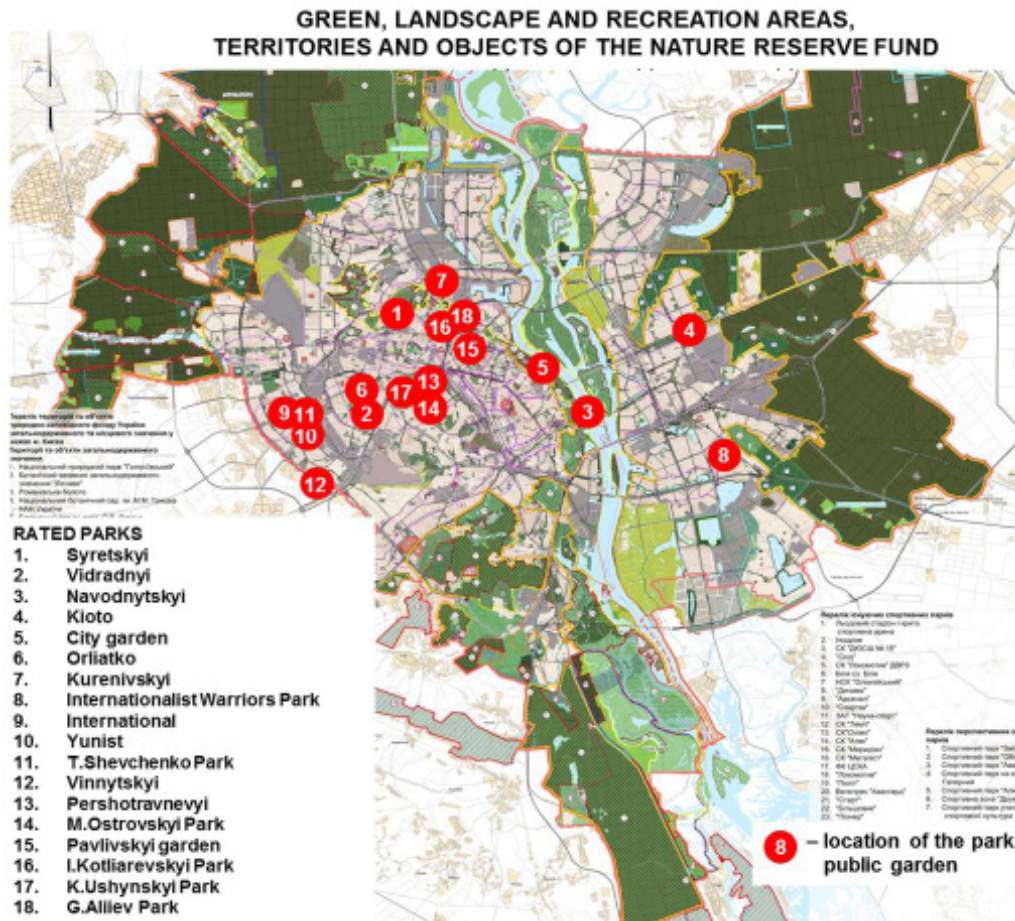

Fig. 2. Placement of the evaluated elements of the landscaping system under the Scheme "Greening and Landscape and Recreation Territories" as part of the Master Plan. Source: own data

Selected landscaping features included local gardens and local nature parks. The area of the investigated landscaping elements ranges from 0.55 ha (Aliyev Square) to 22.40 ha (Syretskyi Park). The landscaping elements selected for the study are mostly surrounded by dense residential and public buildings. There are also instances of these elements being surrounded by industrial buildings, green spaces, transport infrastructure and water bodies.

2.3. Materials and methods

According to Niles (2006), a sample size of minimum 196 participants was required to obtain and analyse results with a confidence level of 95% and confidence interval of 7%, taking into account the population of Kyiv (Ukraine) of 2,885,000 inhabitants [30], of which the sample is aimed to be representative.

As such, data were collected from 222 participants (145 female, 77 male), recruited through email and social media advertising. All participants were permanent Kyiv residents, and either working or studying there, or both. One hundred and twelve participants were aged 18–30, ninety-four were aged 30–50 and seventeen were over 50. All participants were educated to at least bachelor's degree or higher.

The study was conducted using an online questionnaire. The questionnaire was conducted in the Ukrainian language. It was built on a Google Forms platform and was completed by participants at their own time and pace, without restrictions.

The questionnaire examined participants' attitudes and opinions about the state of greening, in particular of parks, in Kyiv. Additionally, the survey contained a series of questions examining the participant's habits regarding visiting parks.

Particular attention was paid to prioritising the criteria that residents considered the most important in determining attractiveness of landscaping. The following criteria were examined:

1. *Ecology* (sanitary-hygienic and ecological condition of the park) – the level of noise regime, the level of contamination of the park territory by vehicle exhaust gases; soil contamination by heavy metals: caesium-137, lead, mercury.

2. *Contactability* – the park being surrounded by residential or public buildings, industrial sites, etc.

3. *Accessibility* (location of the park within walking or transport distance from places of residence and work) – availability of metro stations and high-speed tram; availability of stops and number of public transit routes within walking distance of the park.

4. *Attractiveness* (attractiveness of park due to its aesthetically significant qualities) – aesthetics (colour, brightness, shape, spatial structure of objects within the field of view and other features that can influence feelings, mood, emotional impressions, and the physical and psycho-emotional state of a person in general); uniqueness (the presence of objects of historical, architectural and natural heritage, etc.); topology (the presence of impressive landscapes, water bodies, the nature of vegetation distribution, etc.); well-developed infrastructure (availability of entertainment facilities, sites of various purposes, small architectural forms, etc.).

The study comprised a mixture of multiple-choice and checkbox-style questions, as well as an optional open question at the end of the questionnaire. A total of twenty-three questions were asked (excluding those on demographics). Thirteen questions were multiple-choice; seven were checkbox-style and allowed for more than one answer; one was an optional open-ended question; and one question was presented in the form of a matrix table. Some of the multiple-choice and checkbox-style questions had an "other" option that allowed participants to answer freely. The "other" option answers were not used in quantitative analysis, but rather served as a valuable source for the qualitative analysis of data.

3. Results

For the purposes of this study and report, not all questions were analysed. To answer our research questions, ANOVAs and several Student's t-tests were conducted. All the t-tests were Bonferroni corrected where appropriate, to account for multiple

comparisons. Data were analysed for each question individually. The statistical analysis of data revealed the following series of findings.

Firstly, it was revealed that a statistically significant proportion (almost 71% of respondents) believe that there are not enough parks in Kyiv, and that more parks should be built ($t(221)=4.18$, $p=0.015$). Additionally, it was observed that more than 85% of participants considered parks to be a place of quiet rest, and prefer picturesque landscapes. The availability of parks and squares is of utmost importance to Kyiv residents. Forty percent of respondents reported visiting parks at least three times per week, and almost half believe that the attractiveness and uniqueness of the parks are the most important features.

Further, a 2×3 ANOVA was applied, with gender (male vs female) and age (18–30; 30–50; and 50+) as between-subject factors. No main effects were found, though an interaction effect was reported ($t(2,221)=4.08$, $p=0.031$). Further analysis using t-tests showed that although between men and women aged 18–30 or over 50 there was no statistically significant difference as to how often they used parks (in all cases $p>0.050$), women aged 30 to 50 nevertheless used parks more than men ($t(92)=2.44$, $p=0.021$).

To analyse the aim of park usage by age and gender, 2–3 between-factor ANOVA was applied. Again, no main effects were reported, whilst a significant interaction effect was present ($t(2,221)=3.11$, $p=0.049$). Further parsing out with t-tests revealed no difference between age and gender with respect to park usage for quiet rest, entertainment, and cultural events; however, usage of sports equipment (although of borderline significance), was preferred by women aged 30–50, as compared to men ($t(92)=1.99$, $p=0.051$).

Further, four criteria were analysed as to their importance from the perspective of urban effectiveness and public perception. These were: the ecological state, park contactability, park accessibility, and park attractiveness; and can be seen in Fig. 3. Responses revealed that the ecological state of the park was deemed to be the most important criterion by over 80% of respondents. The second most important criterion, chosen by over 67% of participants, was park accessibility. About half reported park attractiveness as an important criterion, and

just under 17% recognised park contactability as important.

More detailed analysis of each criterion also revealed its most important aspects, as rated by the population of Kyiv. For the ecological state of the parks, noise levels (specifically the noise of cars from surrounding highways and roads) and air contamination (from car exhaust fumes) were identified equally as the most important, with around 43% of respondents choosing each option. Levels of soil contamination (with e.g. heavy metals) was only chosen by 14% as the most important aspect of ecological state.

With regards to accessibility, the respondents reported that being able to access the park on foot is the most important, with almost 55% choosing this option. Twenty percent reported that availability of overground public transport stops within walking distance of the park is most important, and 11% and 13% identified the number of public transport routes, and the availability of underground public transport stops, respectively, as the most important accessibility factors.

Finally, in terms of park attractiveness, the aesthetic aspects and topological characteristics were deemed most important, with 35% and 38% respondents, respectively, choosing these options. About 18% identified the uniqueness of the park (presence of historical or architectural monuments, various art objects, etc.), and almost 10% park infrastructure, as the most important aspect determining attractiveness.
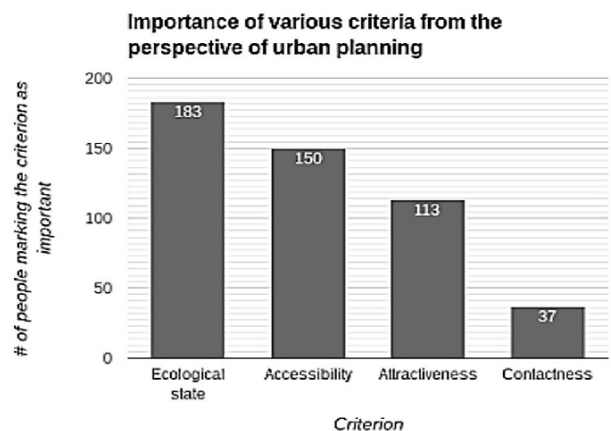

Fig. 3. Numbers of people who deemed each criterion to be an important aspect of parks, from the perspective of urban planning. Source: own data.

4. Conclusions

The ever-increasing global level of urbanisation shows the extraordinary concentration of people in a densely built urban space. The larger the modern city, the more empty, construction-free spaces there are. The system of elements of green space of the city – parks, squares, boulevards – forms the ecological framework of the city and becomes the link that connects man with nature. The existing greening system of the city has important environmental, urban, historical, cultural and social functions, providing the population with a sense of comfort in the urban environment.

Compliance with minimum regulatory requirements for the area of green space and the level of greening of the urban area is regulated by a country's legislation and system of norms relating to urban activity. Regulatory requirements regarding the level of landscaping vary in different countries from 5 to 25 m^2/person. In Ukraine this rate is 16 m^2/person.

In this study, we analysed both the actual state of provision of green spaces for public use and the subjective attitude of residents to the level of greening in the city of Kyiv. According to the materials of the City Master Plan, the level of greening in Kyiv is 18.5 m^2/person, and long-term provision will reach 23.5 m^2/person.

Using only absolute indicators (the area of green space and its share in the total area of the city), or even relative indicators (the level of green space provision of the population – m^2/person) does not allow sufficiency of existing greening or the state of greening of the city to be truly estimated. Given the fact that the green areas in Kyiv are technically adequate and the level of landscaping is in accordance with the current regulatory requirements (18.5 m^2/person, compared to the 16.0 m^2/person required by regulations), the overwhelming number of interviewed residents (over 71%) reported feeling a lack of landscaping.

Moreover, the subjective evaluation by the population is different. Residents (Vasilyuk, 2004), public figures of Kyiv (Derkulsky, 2016), as well as scientists (Arion et al., 2016), constantly claim that the number of green spaces in Kyiv is catastrophically decreasing, and that parks, squares and green areas are being destroyed for construction purposes.

The subjective and objective assessments of green space provisions, made on the example of the city of Kyiv, are significantly different. Such estimates sometimes reach polar opposite values, depending on the method of evaluation used.

Kyiv ranking as the single greenest capital in Europe according to the NDVI method can be explained by the features of the planning organisation of the city's ecological framework.

The system of green spaces of various functional in the city of Kyiv, which occupies more than 50% of its territory, has existed for several centuries and is of a permanent nature. The spatial organisation is significantly influenced by factors such as city planning being disjointed between its right-bank and left-bank portions, and the fact that a large area is covered by the Dnipro River area with right-bank park slopes and green islands in the central part of the city, together forming the so-called 'water-green diameter' of the city (see Fig. 2). The middle zone of the city, developed for residential public and industrial-warehouse development, is surrounded by an extensive forest park belt in the peripheral part of the city.

The results from Gärtner show that about 40% of the analysed area (a zone of 5 km radius around the city centre, see Fig. 1.2) is occupied by water-green diameter elements of Kyiv – the territory of the Venetian Islands (Hydropark Park), Dolobetsky, Trukhanov-1 and Gorbachich tract; unique landscaped right-bank slopes of the Dnipro River (Volodymyr's Hill, Khreshchaty, City, Mariinsky, Askold's Tomb, Glory Park, Naddnipryansky, Pechersk Lavra Parks) and the Grishko National Botanical Garden NAS of Ukraine and the Fomin Botanical Garden. This is what contributed to the high Normalised Difference Vegetation Index.

This extraordinary concentration of parks gives a unique view of the central area of Kyiv, but the vast area of other built-up zones of the city has only a few small intersections of green areas, parks and squares. The lack of green spaces for public use is really felt by the residents of the vast majority of residential areas and arrays of Kyiv.

Given the limited free areas for the establishment of new parks and squares, the leading approach to improving the greening system of Kyiv is

to increase the attractiveness of the existing green areas. The criteria for assessing the attractiveness of parks and squares were determined in this study: environmental friendliness of the park (including both ecological and sanitary conditions), contactability of the park (being surrounded by residential, public or industrial sites, etc.), accessibility to the park (its location within walking distance or transport accessibility from places of residence and work) and the attractiveness of the park (its aesthetics and purpose). Among these criteria the most important were determined to be environmental friendliness (over 80% of respondents) and accessibility of the park (over 67%).

It was the insufficient level of comfort and ecological state of the urban environment and, in particular, of the city's ecological framework – which residents identified as the most important characteristics of elements of a green space system – that determined the last place in the ranking conducted by German industrial giant Siemens (Taylor, 2009).

Placing individual greening fragments in areas surrounded by dense urban development ensures that residents' priority criteria of accessibility of parks and squares will be met. This preference was stated by over 67% of participants. This allows you to pay more attention to increasing improvement to, and attractiveness of, green areas. Interestingly, according to the survey, among the 18 proposed parks, only three were actively visited – the City Garden (66.7%); Shevchenko park (66.2%) and the park of Ostrovsky (41.0%), which have a rather small areas but a high level of landscaping and rich entertainment facilities for both adults and children.

In summary, it can be concluded that creating new elements of a system of green spaces (parks and squares) that require significant territorial resources is too problematic given the dense urban development and high cost of land in the city of Kyiv. Therefore, increasing the level of improvement to, and attractiveness of, the existing elements of the city's green space system should be a priority to ensure a sense of urban comfort and meet the need for green areas.

References

Arion, O.V. Kupach, T.G. Demyanenko, S.O. (2016). Recreational fitness of green spaces in Kyiv. *Geology. Geography. Ecology,* 45: 113-122.

Burgess, J. Harrison, C. Limb, V. (1988). People, parks and the urban green: a study of popular meanings and values for open spaces in the city. *Urban studies*, 25(6): 455–473. https://journals.sagepub.com/doi/10.1080/00420988820080631

DBN B.2.2-5: 2011. Improvement of territories. (2012). *State Building Standards of Ukraine. Kyiv. Uarkhbudinform.*

DBN B.2.2-12: 2019. Planning and development of territories. (2019). *State Building Standards of Ukraine. Kyiv, Uarkarhbudinform.*

Derkulsky, R.Yu. (2016). Current status and tendencies of use of green areas in Kyiv *Environmental protection. Balanced nature management,* 2: 88-93.

Gärtner, P. (2017). European capital greenness evaluation. https://philippgaertner.github.io/2017/10/european-capital-greenness-evaluation/

Golub, A. (2016) Has Kiev remained green? *Week.ua.* http://tyzhden.ua/Society/176107

Gupta, K. Roy, A. Luthra, K. Maithani, S. (2016). GIS based analysis for assessing the accessibility at hierarchical levels of urban green spaces. *Urban forestry & urban greening*, 18: 198–211. http://agris.fao.org/agris-search/search.do?recordID=US201600187743

Horyshina, T.K. (1991). Plant in the City. *L .: Izd in LSU,* 150.

Ignatieva, M.E. (2002). Urban Ecology: Formation and Development. *Landscape architecture. Design,* 1(44): 10–14.

Krefis, A. Augustin, M. Schlünzen, K. Oßenbrügge, J. Augustin, J. (2018). How Does the Urban Environment Affect Health and Well-Being? A *Systematic Review Urban Sci,* 2, 21.

Kryzhanovsky, Y.M. Nagorna, A.V. (2014). Development of the biocentric network structure of the ecological network of the city of Vinnytsia using geoinformation technologies. *East European Journal of Advanced Technology,* 6/10: 8-12. http://kruzhan.vk.vntu.edu.ua/file/0ffbcf977e1b2b06d99db2a6e5c24fa8.pdf

Kweon, B.S. Sullivan, W.C. (1998). Green common spaces and the social integration of inner-city older adults. *Environment and Behavior,* 30(6): 832-858.

Malyuga, V., Yukhnovsky, V. (2012). Pryntsypy formuvannia ekolohichnoi merezhi Ukrainy [Principles of developing the ecological network in Ukraine]. *Lisove i sadovo-parkove hospodarstvo – Forestry and gardening.* http://journals.nubip.edu.ua/index.php/Lis/article/viewFile/9633/8616

Mashinsky, V.L. Zologina, E.G. (1978). Designing greening residential areas. Moscow, Stroyizdat.

Niles, R. (2006). Survey Sample Sizes and Margin of Error. http://www.robertniles.com/stats/margin.shtml

Oleinychenko, V.D. (2011). Ecological network as a way to reproduce environmental stability. *Scientific Articles Digest of the "III All-Ukrainian Congress of Ecologists with International Participation"* Vinnytsia, 1: 233–236.

On the National program for the formation of the national ecological network of Ukraine for 2000-2015. (2000). *Law of Ukraine, 1989-III.* https://zakon.rada.gov.ua/laws/show/1989-14

Planet Garden. (2012). Global Environmental Report 2012 (A closer look at green spaces in cities around the world). http://www.husqvarna.com/files/articles/RUS_GGR_2012_Final.pdf

Pleshkanovska, A.M. Usova, O.S. (2014). Some green building issues in the modern city. *Modern Problems of Architecture and Urban Planning,* 36: 331-336.

Public parks. Seventh Report of Session 2016–17. (2017). *House of Commons Communities and Local Government Committee. Published on 11 February by authority of the House of Commons.* 87. https://publications.parliament.uk/pa/cm201617/cmselect/cmcomloc/45/45.pdf

Romanyuk, I. (2014). 'Quality of life' as a socio-economic category and object of statistical research. *Economics,* 4(157): 91-98.

Rules for maintaining green space in settlements of Ukraine. (2006). https://zakon.rada.gov.ua/laws/show/z0880-06

Selmi, W. Weber, C. Rivière, E. Blonda, N. Mehdi, L. Nowak, D. (2016) Air pollution removal by trees in public green spaces in Strasbourg city, France. *Urban Forestry & Urban Greening,* 192-201. https://www.fs.fed.us/nrs/pubs/jrnl/2016/nrs_2016_selmi_001.pdf

Shvets, V.V. Rudenko, K.S. Veremii, O.H. (2010). The formation of the ecological framework of the city. Shelters under the green cover. *Modern technologies, materials and structures in construction,* 2: 139-143.

Strategic Initiative "Dnipro Pearl". (2011). *Kyiv, Kyiv City Council.* https://dp.kga.gov.ua/uk/strategichna-initsiativa-dniprovska-perlina/strategiya-rozvitku-m-kieva-do-2025-r

Swanwick, C. Dunnett, N. Woolley, H. (2003). Nature, role and value of green space in towns and cities: An overview. *Built Environment,* 29(2): 94-106. https://www.jstor.org/stable/23288809?seq=1

Taylor, C. (2009). Dublin fares badly in green survey. *The Irish Times.* Tue, Dec 8, 2009. https://www.irishtimes.com/news/dublin-fares-badly-in-green-survey-1.850334

The Master Plan of Kyiv. Substantive provisions. (2015). Kiev. https://drive.google.com/file/d/0BxbGBoNdb-1j6TTRuS3RMQjFINTA/view

Town planning: Planner's guide. (2001). Edited T.F. Panchenko. *Kyiv.: Ukrarhbudinform.*

Trubina L. K. Nikolaieva O.N. Mullaiarova P. I. Baranova Y. I. (2017). GIS inventory of urban green spaces. *Cartography and geoinformatics. Bulletin of SSUGT,* 3: 107-118. https://cyberleninka.ru/article/n/inventarizatsiya-gorodskih-zelenyh-nasazhdeniy-sredstvami-gis

United Nations. (2015). *Transforming Our World, the 2030 Agenda for Sustainable Development.* General Assembly Resolution A/RES/70/1.

Van Herzele, A. Wiedemann, T. (2003). A monitoring tool for the provision of accessible and attractive urban green spaces. *Landscape and urban planning,* 63(2): 109-126.

Vasilyuk, O.V. (2004). Kiev parks are dying !!! *Youth Branch of the National Ecocenter of Ukraine.* April 2004. http://www.lysa-gora.narod.ru/indexpark.html

Wan, C. Shen, G. (2015). Salient attributes of urban green spaces in high density cities: The case of Hong Kong. *Habitat International,* 50: 130–139.

Wolcha, J.R. Byrne, J. Joshua, P. (2014). Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough'. *Newell. Landscape and Urban Planning,* 125: 234–244. http://ced.berkeley.edu/downloads/research/LUP.parks.pdf

Zviryaka, A.I. (2011) The monumental status of the historic landscape of the Kiev Mountains and the Dnipro River. *Works of the Center of history of Monuments,* 20: 9331–336.