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Biodiversity of woody plants in a small town: The example of Kagarlyk (Ukraine)

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Abstract. Assessing the biodiversity of woody plants in small Ukrainian towns is essential for informed urban greening strategies, especially in the context of climate resilience and the lack of systematic street tree inventories. The purpose of the work was to determine the species composition and level of biodiversity of woody plantings of the small city and compare the results obtained with previously studied small cities of the region. The research was conducted

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in 2023-2024 in Kagarlyk town, Kyiv region, Ukraine. A systematic approach, general scientific and special methods, in particular dendrological, were used. An inventory of various types of green spaces in Kagarlyk downtown was conducted, based on the results of which the woody species diversity index (SDI) was determined both for individual studied objects and for the studied town's territory as a whole. It was established that the studied woody plantings of Kagarlyk, especially street and school areas, are characterised by a low level of biodiversity of woody species. A higher level of biodiversity was characteristic of the park and adjacent to residential buildings areas. The overall biodiversity index of urban woody plantings was low, at 7, which is lower than in previously studied towns. It was found that the level of species diversity of woody plantings in Kagarlyk town is low: the SDI index is 6.9, with 51% of all trees belonging to just two species – *Aesculus hippocastanum* and *Fraxinus excelsior*. The highest level of diversity was recorded in the park and near-residential areas, while street and school plantings showed particularly low values, indicating the need for diversification of species composition. The predominance of *Aesculus hipocastanum* and *Fraxinus excelsior* does not guarantee the long-term sustainability of the town's green spaces. The results will allow assessing the relative resilience of the urban area to new natural challenges, in particular to global climate change

Keywords: park-monument of landscape art; school territory; species diversity index; street plantings; woody species

Introduction

Urban vegetation contributes to the ecologically balanced development of the city territory, and its structure is key to the possibility of preserving biodiversity. In turn, the species diversity of urban plantings is a significant ecological factor by which the impact on the environment is assessed, and is also a key factor in the resistance of green plantings to pests, diseases and climate change (Cowett & Bassuk, 2017). Therefore, increasing the diversity of street trees is considered a step towards ecologically balanced development, and assessing diversity is an integral part of sustainable management. In urban conditions, there is a complex impact of negative factors on woody plants, which requires a differentiated approach to the selection of their species composition, taking into account stability and planting categories. A rich species composition of plants is promoted in view of the performance of various, both sanitary and hygienic, and psychophysiological functions by green plantings. Various indices are usually used to assess the diversity of street trees, among which the inversion of the Simpson index is considered one of the best indicators. The combination of climate change and accelerated urbanisation creates new challenges for urban land-use planning and contributes to growing interest in restoring urban ecosystems. The main objective of the EU Biodiversity Strategy is to contribute to limiting climate change and increasing Europe's resilience, which generates a new demand for sustainable, adaptive, environmentally safe cities and addressing critical vulnerabilities. Green infrastructure plays a key role in this (Moraci *et al.,* 2025).

Climate adaptation in cities is a complex issue and one of the main collective challenges of society, where the relationship between city managers and citizens faces many challenges (Romero-Muñoz *et al.*, 2024). Z. Türkay & A. Tezer (2024) noted that urbanisation reduces the diversity of local species on a regional scale, but the overall species richness of plants in cities is often extremely high. However, global ecosystem biodiversity and their ecosystem services are declining. Thus, global risks associated with climate change are exacerbated. According to M. Clemente *et al.* (2025), street trees and urban forestry have now become central topics in international discussions and government policies aimed at combating climate change and promoting sustainable development. Cities are implementing strategic programs to increase street tree populations to enhance resilience and mitigate the environmental impacts of urbanisation. However, the trend toward increasing species diversity in street tree plantings requires a balance between preserving the unique character of each neighborhood and meeting the need for resilient, stable, and climate-adapted species. Strategic planning should combine the preservation of historic landmarks with forward-looking solutions, ensuring that the urban landscape remains unique and resilient.

According to B. Ma *et al.* (2021), urban planning should be biodiversity-based and use inventory data to design balanced and sustainable green spaces. the most common inventory is for street and park trees. In the study by M. Sarigu *et al.* (2025) noted that in Assemi (Italy), the highest biodiversity was found in the "Green Zones" and "Schools", which are vital reserves of urban biodiversity, while providing opportunities for learning and recreation. Authors researched thst streets present less biodiversity due to space constraints and design priorities focused on shading and aesthetic appeal. This reduction in diversity can increase vulnerability to environmental stresses. M. Sarigu *et al.* emphasised the importance of prioritising native species adapted to local bioclimatic conditions, which prevents resource depletion and protects local biodiversity from risks of invasion. At the same time, over-reliance on a limited number of adapted species can pose risks and lead to the homogeneity of the urban flora and limited resilience to environmental stresses. The high percentage of exotic species confirms the impact of globalisation; in particular, the use of fashionable ornamental species.

A. Mizgajski *et al.* (2023) demonstrated that in Lviv (Ukraine), new plantings have a large proportion of local tree species. In contrast, in the cities of Southern Ukraine, introduced species adapted to local conditions are mainly used to create parks and gardens (Melnyk *et al.*, 2021). O. Zibtseva (2021) established that the level of biodiversity of tree species in small Ukrainian cities is influenced by their proximity to large cities, in particular to the capital, and closer and more economically developed small cities often have higher biodiversity indicators. In the studied small cities of the Kyiv region, the highest level of biodiversity is characterised by the territories of newly created public gardens and the adjacent territories of multi-apartment residential buildings. In addition, the share of introduced tree species of various objects in small cities often exceeds the share of local tree species (Feschenko *et al.*, 2021).

A. St-Denis *et al.* (2024) emphasised the importance of urban tree diversity for increasing ecosystem resilience, as low tree species diversity in streets can lead to significant loss of plant cover in the event of large-scale disturbances such as drought or exotic pest or disease. The authors proposed a new software SylvCiT for decision-making on urban tree plantings. SylvCiT provides a clear spatial portrait of the urban forest: species richness, functional diversity, structural diversity, identifies underrepresented tree species, and provides recommendations for increasing diversity to increase resilience to global change.

The relevance of research on the biodiversity of tree plantations of a typical forest-steppe

Ukrainian small city is enhanced by the lack of reliable information on the quality of existing green spaces in small cities. However, modern challenges, both global and local, and the future post-war reconstruction of cities will require clear knowledge of the current situation in order to develop promising plans for the restoration of sustainable urban ecosystems. The aim of this study was to assess the diversity and species composition of woody plants in a small urban environment.

Materials and Methods

Research object. Characteristics of the Kagarlyk territory. Kagarlyk town, mentioned as early as 1142, currently occupies an area of 2130.7 hectares and has a population of over 13100. The town is located 77 km from the capital of Ukraine within the forest-steppe zone (Zibtseva *et al.*, 2024) (Fig. 1).

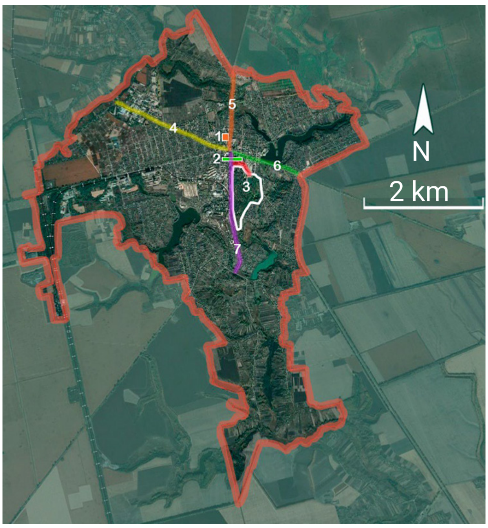

Figure 1. The scheme of Kagarlyk town location on the territory of Kyiv region, Ukraine

Note: 1 – near-house territorie; 2 – school territorie; 3 – park-monument; 4 – Kashtanova Str.; 5 – Stolychna Str.; 6 – Nezalezhnosti Str.; 7 – Parkova Str.
Source: developed by the authors

Kagarlyk is a compact town with a radial planning structure. Residential development is represented mainly by blocks of low-rise estate buildings and medium-rise buildings in the central part of the town. The town is focused mainly on agricultural production and is moderately efficient in terms of economic efficiency. Kagarlyk is notable among other small cities in the Kyiv region for its relatively high provision of public green spaces, which amounts to 73.0 m^2 per capita. In the central part of the town there is a park-monument of landscape art of national importance "Kagarlytsky" with an area of 29.5 hectares. In total, Kagarlyk has 100.8 hectares of public green spaces. This is one of the few small cities where the normative indicators of urban greening are met: the greening norm (the normative minimum number of public green spaces in m^2 per capita) and the level of greening (Zibtseva, 2021). At the same time, the town does not have a developed suburban green zone in the form of protective forest areas, and is mostly surrounded by plowed fields, which is also typical for small Ukrainian cities. Also negative environmental phenomena in the Kagarlyk's territory are the systematic destruction of wetlands, the prospective halving of the area of urban forests, and the increase in fragmentation of urban forests, which will potentially reduce the eco-stability of the urban area.

Methodology. The study of the biodiversity of tree species was based on an inventory of various types of green spaces conducted within the territory of Kagarlyk.Green spaces for general use (parks), limited use (near-house and school territories), and special-purpose green spaces (street plantings) were studied. An inventory of woody plantings was conducted on the streets of the central part of the town, since street woody plantings are usually absent on the periphery. Also, an inventory of woody plants in the school territory and the near-house territory of an apartment building was conducted in the central part of the town. In addition, data from inventories of the park-monument of landscape art "Kagarlytskyi" conducted by various researchers (in particular, Yu. M. Klymenko (1999) from the National Botanical Garden of the National Academy of Sciences of Ukraine named after M.M. Hryshko). The study was conducted in accordance with the Convention on Biological Diversity (1992).

During the inventory on the territory of each object, the number of specimens and species of trees, shrubs and lianes, their age, and condition were determined. The assessment of the condition of trees was carried out visually on a five-point scale, where 1 point indicated plants in excellent condition, 2 points – woody plant in good condition, 3 – woody plant in satisfactory condition, 4 – woody plant that are drying out and 5 points – withered woody plant (Kuruneri-Chitepo & Shackleton, 2011). To assess species diversity, the woody plant species diversity index (SDI) – the inverse of the Simpson index – was calculated, allowing for linear comparisons of tree species diversity levels at different sites (Sun, 1992):

$$SDI = \frac{\sum Nj \times (\sum Nj - 1)}{\sum Nj(Nj - 1)}, \qquad (1)$$

where *Nj* – is the number of trees of a certain species in the total number of woody plants. A higher *SDI* value indicates a higher level of diversity, and an SDI value close to 20 indicates the stability of the stands.

Results and Discussion

Traditionally for small cities, the street landscaping with trees is presented only on the central main streets in Kagarlyk town (Fig. 2).

Figure 2. Street landscaping of Kagarlyk town
Note: downtown and surroundings
Source: photo of the author O. Shandrenko

For example, on one of these main streets – Parkova street – there are seven tree species, among which the largest number of specimens (42.2%) belongs to *Aesculus hipocastanum*, 31.3% – *Fraxinus excelsior*, 15.6% – *Acer platanoides*. In addition, 3.1% of tree specimens are *Tilia cordata*, *Betula pendula* та *Acer negundo* L. and 1.6% – на *Populus tremula* (Table 1).

Table 1. Characteristics of tree plantations in Parkova Street

Species name	Quantity, %	Age, years	Diameter, cm	Height, m	Condition, points
Aesculus hipocastanum	42.2	50	32 ± 2.9	12 ± 2.0	3 ± 0.4

Table 1, Continued

Species name	Quantity, %	Age, years	Diameter, cm	Height, m	Condition, points
Fraxinus excelsior	31.3	60	46±8.8	13±1.9	3±0.5
Acer platanoides	15.6	50	34±6.5	10±2.2	3±0.5
Acer negundo	3.1	40	80	16	3
Tilia cordata	3.1	40	16	8	3
Betula pendula	3.1	40	32	12	4
Populus tremula	1.6	60	54	18	3
Total SDI	100				3.4

Source: developed by the authors

Contrary to the current regulatory ratio of trees and shrubs (1:10), shrubs in street landscaping occur only singly. The condition of street trees is mostly satisfactory. The age of street trees, as a rule, ranges from 40 to 60 years. The SDI biodiversity index is low and for Parkova Street taken separately is only 3.4. In total, according to the results of the inventory of the five central streets of Kagarlyk, 26 tree and shrub species were identified in street plantings, dominated by *Aesculus hippocastanum* (a total of 44.1% of specimens among the inventoried trees), *Tilia cordata* (17.6%) and *Fraxinus excelsior* (15.6%). Among the presented species, only *Fraxinus excelsior* is characterised by relative drought resistance (Fig. 3).

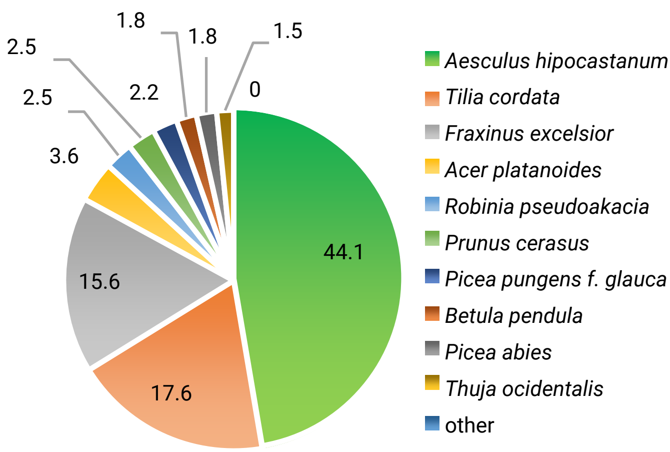

Figure 3. Species structure of the studied street plantings of Kagarlyk town
Source: developed by the authors

In general, in the studied street plantings of Kagarlyk town, only three coniferous tree species were found singly: *Thuja ocidentalis, Picea pungens f. glauca* and *Picea abies,* and were found only three deciduous shrub species: *Syringa vulgaris* L., *Spirea Vanhoutea* and *Forsythia europae* Deg. et Bald., and only within two streets (Table 2).

Table 2. General characteristics of the biodiversity of street plantings in Kagarlyk town

Street name	Number of species	Prevailing species		SDI
		Species name	%	
Parkova	7	*Aesculus hippocastanum*	42.2	1.83
		Fraxinus excelsior	31.3	
		Acer platanoides	15.6	
Stolichna	10	*Tilia cordata*	54,3	2.96
Kashtanova	20	*Aesculus hippocastanum*	21.5	6.57
Nezalezhnosti	7	*Acer platanoides*	16.7	4.43
		Tilia cordata	41.6	
Stadionna	1	*Aesculus hippocastanum*	100.0	-
All streets	26	*Aesculus hippocastanum*	44.1	3.95
		Tilia cordata	17.6	
		Fraxinus excelsior	15.6	

Source: developed by the authors

Half of the species represented in street plantings are drought-resistant, but woody plants with medium moisture requirements predominate in terms of number of specimens. Kagarlytsky Park was founded in the 19th century on an area of 40 hectares. It received the status of a park-monument of landscape art of national importance in 1972. At the time of the park's foundation, 113 species of dendroflora were represented here, and in the 1960s-1990s, the park had from 35 to 74 species. As of 2009, Kagarlytsky Park had an area of 34 hectares and included 63 taxa (Spriaghailo, 2010). In 2015, the State Enterprise "National Research and Development Institute of Urban Planning" developed a project for the reconstruction of the park, which is gradually being implemented. Currently, the presence of dendroflora species may differ slightly, which was influenced by both the storm of 2023 and the reconstructive restoration measures that have been carried out since 2020.

Figure 4 shows the species structure of tree plantations in the Kagarlytskyi Park-Monument of Landscape Art. In general, the park is quantitatively dominated by introduced plants, including *Styphnolobium japonicum* L., *Pseudotsuga menziesii* (Mirb.) Franco, *Pinus strobus* L., *Larix sibirica* Ledeb., *Celtis occidentalis* L. and others. The biodiversity index SDI of the park plantations is 7.0, which is explained by the significant predominance only of several species, namely a significant share of *Fraxinus excelsior*, *Aesculus hippocastanum, Carpinus betulus* L. and *Acer platanoides* L., which account for more than half of the represented tree specimens, as well as the presence of numerous only single specimens of a number of species.

It is obvious that in the near future the biodiversity of the park will increase somewhat, which is explained by the attention and landscaping activities of recent years. To determine the biodiversity of trees in green spaces of limited use, tree plantations on the school grounds (Table 3) and the adjacent territory of an apartment building (Table 4) were examined.

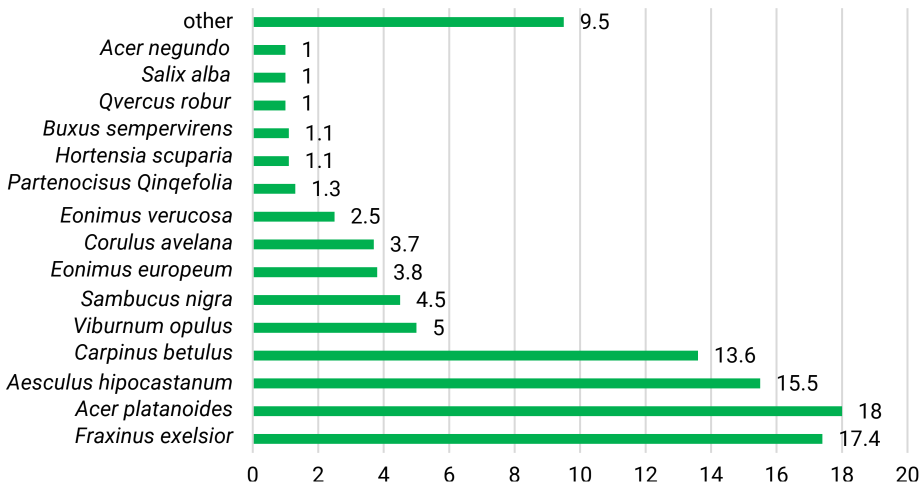

Figure 4. Species structure of tree plantations of Kagarlytskyi Park, %

Source: developed by the authors

Table 3. Characteristics of woody plantings on the school area in Kaharlyk town

Species name	Quantity, %	Age, years	Diameter, cm	Condition, points
Tilia cordata	46.8	50	36	3
Picea abies	13.3	60	40	3
Aesculus hippocastanum	13.3	30	24	3
Prunus cerasifera Ehrh.	13.3	40	24	3
Juglans regia L.	13.3	10	16	2
Total SDI	100			4.2

Source: developed by the authors

The SDI of the school area is currently very low, at the level of 4.3, which clearly does not encourage students to be interested in the natural wealth and diversity of woody plants. The SDI of the researched area of the apartment building in the central part of the town is traditionally (based on previous observations) the highest for the urban area, but also relatively not high and is 10.4.

In the area close the apartment building (Table 4) are singly presented *Prunus persica* (L.) Batsch., *Morus alba* L.¸ *Prunus domestica* L., *Picea pungens* Engelm., *Tilia cordata* Mill., *Malus pumila* Mill., *Cotoneaster lucidus* Schltdl., *Berberis thunbergii* DC., *Forsythia europaea* Degen & Bald, *Spiraea* × *vanhouttei* (Briot.) Zabel., the number of each species from 0.7 to 1.5%.

Table 4. Biometric characteristics of woody plantings in the area close the apartment building

Species name	Quantity, %	Age, years	Condition, points
Rubus idaeus L.	22.2	5	2
Viburnum opulus L.	16.3	12	1

Table 4, Continued

Species name	Quantity, %	Age, years	Condition, points
Syringa josikaea Jacq. ex Rchb	7.4	10	2
Vitis vinifera L.	7.4	15	1
Malus domestica Bork	5.9	16±3.5	1.4±0.5
Parthenocissus quinquefolia L.	5.9	15	1
Juglans regia L.	4.4	21±6.3	1.5±0.5
Rhus typhina L.	3.0	9±2.5	1
Prunus cerasus L.	3.0	15	2
Rosa arvensis Huds.	3.0	10	2
Rosa hybrida L.	3.0	5	2
Prunus armeniaca L.	2.2	25	2
Hydrangea paniculata Siebold.	2.2	5	1
Buxus sempervirens L.	2.2	5	2
other	11.0	5–25	1
Total SDI	100		10.4

Source: developed by the authors

Figure 5 shows the general species structure of the studied woody plantations in the territory of Kagarlyk town, and Table 5 shows the number of identified species per site and the proportion of tree specimens of introduced species.

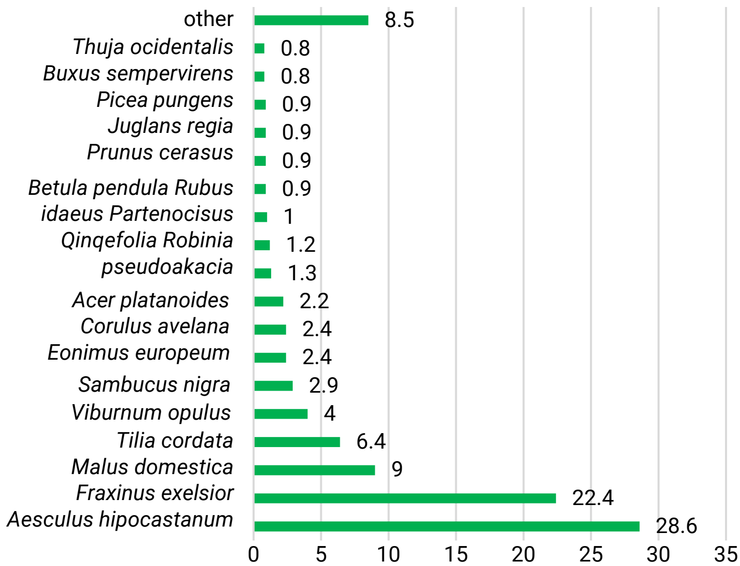

Figure 5. General species structure of the studied woody plantations of Kagarlyk town, %
Source: developed by the authors

Table 5. Biodiversity of woody plantings in the central part of Kagarlyk town

Object (woody plantings)	SDI	Number of species, pieces	Share of introducers, %
Park	7.0	74	78
Apartment building	10.4	24	50
School	4.2	5	27
Streets	4.0	26	45
Together	6.9	83	55

Source: developed by the authors

Thus, more than half (51%) of the tree specimens fall on two species: *Aesculus hippocastanum* and *Fraxinus excelsior,* and on five species (with *Malus domestica, Tilia cordata, Viburnum opulus)* – 70.4%. The SDI for tree plantings varies across the study sites from 4 to 10.4, and on average for the central part of the city is about 7. It is generally accepted that green areas, if rationally organised, significantly affect the most important indicators of environmental quality, and scientifically substantiated selection of tree species resistant to the conditions of the urban environment is the key to ensuring high efficiency and durability of created urban green spaces. At the same time, species diversity is an indicator of the resistance of green spaces to anthropogenic and any other pressure. Given the gaps in research on the territories of small cities, the biodiversity of woody plantations in such small Ukrainian cities as Vyshhorod, Ukrainka and others was previously studied. These studies revealed a predominantly low level of dendroflora biodiversity in small cities; however, the highest indicators were typically recorded in the small city of Vyshhorod, located near the capital, which was taken as a reference point for comparisons. In all cases, green spaces in residential areas – the largest category of green spaces in Ukrainian small towns – demonstrated relatively higher levels of dendroflora biodiversity.

M. Salinitro *et al.* (2019) have come to the conclusion that climate change and the presence of artificially irrigated areas have led to an increase in both hygrophilous and drought-tolerant species within cities. According to A. Roloff *et al.* (2009), a total of 250 urban tree species are used in parks and gardens in Central Europe. The authors proposed a matrix for selecting tree species for landscaping European cities, taking into account projected climate change. In small "cold cities" in China, it is recommended to focus on the use of indigenous tree and shrub species, as well as garden and evergreen plants (Guo *et al.*, 2014). 69 species were identified in the center of Zaporizhzhia, Ukraine (Dubovaya & Fendyur, 2009). V. Bessonova & T. Peresypkina (1997) demonstrated in particular, *Populus boleana* L., *Robinia pseudoacacia* L, *Acer pseudoplatanus* are common in street plantings, and in the private sector – *Cerasus magaleb* L., *Juglans regia* L., *Armeniaca vulgaris* Lam. The dendroflora of Chornomorsk has up to 173 species, which is an order of magnitude higher than the number of natural species and three times the number of species that grew in this territory before the construction of the city began. O. Pikhalo (2010) identified 182 species and 82 ornamental forms of trees and shrubs in the historical part of Kyiv, 118 of which are introduced species. However, there is quantitative data on the mostly small number of species in street plantings in the post-Soviet space, where cities are usually dominated by 10-15 tree species, often invasive, which pose a threat to indigenous phytodiversity and require careful steps to involve them in local phytocenoses (Rogovskyi, 2009).

M. Kolström *et al.* (2011) noted that measures aimed at reducing vulnerability to climate change can be aimed either at reducing sensitivity to adverse climate change or at increasing adaptive capacity to changing environmental conditions. And adaptation measures are crucial. According to C. Leuschner *et al.* (2024) one of the options for adapting to increasing climate stress is the selection of more resistant, uncommon local tree species. Thus, low vulnerability to climate was shown by adult trees *Quercus petraea*, *Acer platanoides*, *Fraxinus excelsior*, *Tilia cordata* and *Carpinus betulus*, among which drought resistance decreases in the given sequence.

The constant deterioration of environmental conditions requires the use of plants with increased drought resistance, viability, and powerful biological potential. L. Tischenko *et al.* (2024) found that *Quercus* species have increased drought tolerance and therefore have great potential for urban areas. A wide range of tolerance has been found for *Acer* species. In contrast, *Pinus sylvestris* was the least drought-tolerant of the tree species studied. *Picea abies* (L.) Karst. and *Fagus sylvatica* were also found to be highly sensitive to drought. *Fagus sylvatica* and *Tilia tomentosa* show higher climatic vulnerability than temperate oaks: *Quercus petraea, Q. frainetto,* and *Q. Cerris* (Kasper *et al.*, 2023). *Larix decidua* Mill. is very vulnerable to drought (George *et al.*, 2017).

Under changing climate conditions, drought can become a critical obstacle for urban trees, especially on roadsides and paved areas (Stratópoulos *et al.*, 2019). For tree plantings in harsh and challenging urban environments, an important selection criterion is the ability to develop a strong and dense root system, which is an important feature of drought tolerance. Acer campestre is known to have high drought tolerance. In contrast, *Tilia cordata* ‘Greenspire’ and *Carpinus betulus* ‘Fastigiata’ were found to be drought-tolerant. According to studies by M. Hirsch *et al.* (2023) transport emissions do not affect the drought tolerance of urban tree species. However, *Acer platanoides* and *Tilia cordata* were particularly drought-tolerant. *Platanus × hispanica* and *Quercus robur* were more tolerant, while *Carpinus betulus* was moderately tolerant.

A team of scientists P. Sicard *et al.* (2018) found that individual tree characteristics, such as species and size, and crown openness, significantly influence their growth in cities and can alter the ability of trees to tolerate drought stress. They recommended choosing non-allergenic species with high ozone removal capacity, resistant to pests, diseases, and drought for urban plantings, namely plants from the genera *Acer sp., Carpinus sp., Prunus sp., Larix decidua*. Local recommendations for the selection of tree species for landscaping should take into account not only their bioecological characteristics, but also specific natural (in particular soil) and urban planning conditions. J. Konarska *et al*. (2023) recommended using *Quercus palustris* and *Tilia europaea* for areas with good growing conditions, and *Aesculus hippocastanum recommended* using for areas with impermeable cover without shading.

O. Zibtseva *et al.* (2024) paid special attention to the study of the biodiversity of street plantings, which, according to the Ukrainian classification, belong to special-purpose green plantings as those subject to maximum pollution (by motor vehicles) and therefore perform primarily an ecological, not a recreational function. In addition, from the perspective of spatial planning, street urban plantings capable of functioning as green infrastructure corridors – ensuring its connectivity – are of particular importance, especially given their documented insufficiency in small cities based on previous studies. Therefore, increased requirements should be imposed on the biodiversity of street plantings, which should ensure their resistance to changing environmental factors and the consequences of global climate change.

According to literature sources, the low diversity of street trees in urban conditions makes the tree population more vulnerable to new stressful conditions. According to W. Sun (1992), the average SDI of 53 street tree populations in different US cities ranged from 9.5 to 13.3 on average. According to the results of current studies of green spaces in Kagarlyk, the total SDI for all studied town's woody plantings was 7, i.e. it was 1.3-1.9 times lower. In general, two species were critical for the small city, the share of which exceeds 15%: *Aesculus hippocastanum* and *Fraxinus excelsior*. This is especially dangerous considering that over the last decade *Aesculus hippocastanum* has been massively affected by the *Cameraria ohridella*, and *Fraxinus excelsior* trees are threatened by the *Agrilus planipennis*. The 5% tree planting criterion proposed by N.L. Bassuk (Sun, 1992) on Kagarlyk's streets is also exceeded *Malus domestica* and *Tilia cordata*. Currently, the well-known 10-20-30 rule for urban plantings has not been implemented in the system for regulating the quality of landscaping in Ukrainian cities. For comparison, 38 species and forms of trees and shrubs were identified in the street plantings of Vyshhorod town, Kyiv regio (Zibtseva, 2021), and the level of biodiversity of Vyshhorod's street plantings is almost three times higher than that of Kagarlyk. However, in both towns the condition of street plantings is currently close to satisfactory.

In the work by E. Grybovich *et al.* (2018) the dynamics of the species composition and the results of research on 19 non-native tree species in four parks of the city of Poltava are presented: Korpusny Sad, Petrovsky Park, Poltava City Park, and Peremoha Park. In four parks-monuments of landscape art of Poltava city there are 50-70 woody species (Grybovich *et al.*, 2018), and in parks-monuments of landscape art of Vinnytsia – from 35 to 120 woody species (Sypliva, 2016). In the park-monument of landscape art of local significance "Fastivsky" there are 43 woody species (Levandovska & Khryk, 2024). Most of the territory of "Fastivsky" park-monument (94.12%) is covered with forests of *Quercus robur* L. (50.8%) and *Pinus sylvestris* L. (21.3%) of artificial origin. The park-monument acquires a special natural value due to oak stands of 101–106 years old and middle-aged exotic trees *Catalpa bign*onioides Walt., *Cuninghamia lanceolata* Hook., *Larix decidua* Mill., *Pinus strobus* L., *Phellodendron amurense* Maxim. In most parks there is a decrease in biodiversity and homogenisation of species composition.

Current study confirms previous findings that relatively higher richness and biodiversity indicators are usually characteristic for woody plantings of residential areas. In contrast to Vyshhorod (Zibtseva, 2021), where ornamental woody plants predominate in residential areas, in Kagarlyk, 65.9% of trees are represented by fruit plants.The extremely low level of tree biodiversity in Kagarlyk town on the school grounds, where only 5 tree species were found (SDI is 4.2), among which the share of introduced species is only 27%. Insufficient attention to the school grounds is unjustified, since diverse landscaping can interest students and encourage them to study natural sciences. In contrast, 45 species and forms of woody and shrub plants were found on the grounds of Vyshhorod's schools. As a result, the total number of woody species and forms in the studied area of Kagarlyk town was 83 against 100 in Vyshhorod town and 27 woody species in Ukrainka town located 35 km north of Kagarlyk (also the Forest-Steppe town with a population of 16 thousand). The share of introduced woody species in the territory of Kagarlyk is 55%, while in the territory of Vyshhorod is 75%. The lowest share of introduced species in Kagarlyk is characteristic for the studied school and street plantings. These same plantings (street and school) are characterised by a lower, satisfactory condition, while park and house plantings are mostly in good condition. The Master plan of Kagarlyk town plans to create another 79 hectares of public green spaces (squares, forest park, park), as a result of which the total number of public green spaces will be 179.8 hectares and will be 112.3 m^2 per capita. However, insufficient attention is paid to street landscaping, no specifically outlined quantitative and qualitative tasks are put forward. It is considered advisable to prioritise street landscaping, particularly with regard to its species composition and the presence of a regulatory number of shrubs.

It necessary to recommend diversifying the structure of urban tree plantations (species and age composition) to prevent potential threats and challenges, in particular due to the increasing aridity of the climate. Currently, such drought-resistant species native to the Forest-Steppe of Ukraine as *Quercus robur, Acer campestre, Prunus spinosa, Crataegus monogyna, Rosa canina, Rhamnus cathartica, Cornus mas*. It is also advisable to further use in the landscaping of the city such drought-resistant and moderately drought-resistant species as: *Prunus armeniaca* L*., P. Cerasifera* Ehrh., *Robinia pseudoacacia* L*., Malus niedzwetzkyana* Dieck., *Picea pungens* Engelm., *Juniperus sabina* L*., J. Virginiana* L., *Betula pubescens* Ehrh., *Sorbus aucuparia* L*., Berberis thunbergii* DC., *Crataegus* Tourn. ex L., *Ribes aureum* Pursh., *Cotoneaster* Medik., *Cotinus coggygria* Scop.

The conducted study has demonstrated that the species composition of woody plants in Kagarlyk town is characterised by moderate overall diversity, with a predominance of a few species, particularly *Aesculus hippocastanum* and *Fraxinus excelsior*. The species richness and SDI values vary significantly across green space types, being lowest in school plantings and highest in residential areas. Despite a sufficient quantity of green spaces, the qualitative indicators of biodiversity – especially in street and educational plantings – remain unsatisfactory, which increases the vulnerability of urban ecosystems to climate change and anthropogenic pressures. These findings highlight the urgent need to diversify urban dendroflora and strengthen street landscaping policy as part of integrated green infrastructure development.

Conclusions

Reliable information not only on the quantitative but also on the qualitative indicators of woody plantings, obtained as a result of their inventory, is a necessary prerequisite for ensuring environmentally balanced development of urbanised areas. In small cities of Ukraine, an inventory of street woody plantings has never been carried out. Analysis of the inventory data of woody plantings, conducted in Kaharlyk town, Kyiv region, showed that 83 species and forms of trees and shrubs are represented in the town's greenery. The index of woody species diversity of urban spaces is low, only 6.9. At the same time, the highest diversity index is characterised by woody plantings in parks and adjacent areas, and the lowest - street and school areas. The most common in the town are the trees *Aesculus hippocastanum* and *Fraxinus excelsior*, and that threatens the sustainability of urban landscape.

According to the results, the SDI for street plantings averaged 4.0, with the lowest value of 1.83 recorded on Parkova Street and the highest value of 6.57 on Kashtanova Street. In Kagarlytsky Park, the SDI reached 7.0, although more than 50% of specimens belonged to just four species. On the school grounds, only five species were identified, with an SDI of 4.2, while the area near the apartment building had 24 species and an SDI of 10.4. Overall, 51% of all trees in the study were concentrated in just two species: *Aesculus hippocastanum* and *Fraxinus excelsior*. These results highlight the need for diversification of species composition, especially in street and school plantings.

First of all, the street plantings of Kagarlyk need better landscaping with drought-resistant trees and shrubs for all town's streets, not just its central part. Also, the landscaping of school areas with the inclusion of various species and forms of trees and shrubs requires priority attention. It is recommended to continue to diversify the structure of urban woody plantings to prevent potential threats and challenges. The created urban plantings should reduce the dominance of any one species, avoid species that are particularly sensitive to pests, and take into account the prospective increase in aridity of the climate.

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Conflict of Interest

None.

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Біорізноманіття деревних рослин у малому місті: приклад Кагарлика (Україна)

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Анотація. Оцінка біорізноманіття деревних рослин у малих містах України має важливе значення для розробки обґрунтованих стратегій озеленення міст, особливо в контексті стійкості до зміни клімату та відсутності систематичних інвентаризацій вуличних дерев. Метою роботи було визначити видовий склад та рівень біорізноманіття деревних насаджень малого міста та порівняти отримані результати з раніше дослідженими малими містами регіону. Дослідження проводились у 2023-2024 рр. у м. Кагарлик Київської області. Використано системний підхід, загальнонаукові та спеціальні методи, зокрема дендрологічні. Проведено інвентаризацію різних типів зелених насаджень центральної частини міста Кагарлик, за результатами якої визначено індекс видового різноманіття деревних порід (SDI) як для окремих досліджуваних об’єктів, так і для досліджуваної території міста в цілому. Встановлено, що досліджувані лісові насадження Кагарлика, особливо вуличні та шкільні території, характеризуються низьким рівнем біорізноманіття деревних видів. Вищий рівень біорізноманіття характерний для парку та прилеглих до житлової забудови територій. Загальний індекс біорізноманіття міських деревних насаджень був низьким – 7, що нижче, ніж у раніше досліджених містах. Виявлено, що рівень видового різноманіття деревних насаджень у місті Кагарлик є низьким: індекс SDI становить 6,9, при цьому 51 %

усіх дерев припадає лише на два види – *Aesculus hippocastanum* та *Fraxinus excelsior*. Найвищий рівень різноманіття зафіксовано в парку та на прибудинкових територіях, натомість вуличні й пришкільні насадження характеризуються особливо низькими показниками, що свідчить про потребу в диверсифікації видового складу. Переважання *Aesculus hipocastanum* та *Fraxinus excelsior* не гарантує довгострокової стійкості зелених насаджень міста. Отримані результати дозволять оцінити відносну стійкість міської території до нових природних викликів, зокрема до глобальних змін клімату

Ключові слова: парк-пам'ятка садово-паркового мистецтва; територія школи; індекс видового різноманіття; вуличні насадження; деревні породи