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@ Correspondence author
M. M. Radomska
m.m.radomskaya@gmail.com

M. M. Radomska
National Aviation University, Kyiv, Ukraine

BIODIVERSITY BASED SOLUTIONS FOR THE SUPPORT OF ECOSYSTEM SERVICES, PROVIDED BY URBAN GREEN INFRASTRUCTURE

Compact living of the population in the territory of modern cities on the one hand increases requirements for the quality of environmental conditions, and on the other hand creates an excessive load on the city ecosystem. Green spaces are the main providers of ecosystem services in cities, as urban fauna represented by a very limited number of species. The quality and range of ecosystems of their services, which provided by natural plant associations and urban green spaces, is significantly different and affected by human activity. The assessment of the quality of provision of ecosystem services by the parks of the left bank of the city was carried out Kyiv. At the first stage of the work, an assessment of the potential of service provision was carried out according to 10 criteria. At the second stage, the ratio between cultural and regulatory ecosystem services provided by the parks was performed using pair-wise weighted evaluation. The assessment results show that large, little-altered forest parks provide the highest degree of services, in which regulatory services dominate over recreational ones. Along with this, small lakes ecosystems under the condition of limited recreational improvement and use can also provide more services of a regulatory nature. Traditionally, the main means of ensuring the ecosystems services and adaptation of cities to the conditions of a changing climate are nature-based solutions. Given the scarcity of free space, such solutions include a number of conceptually new approaches that provide maximum involvement of spatial resources of the city, in particular walls and roofs. Such decisions are important and effective, but technical aspects may delay their implementation. Under such conditions it is proposed to pay attention to biodiversity-based solutions, i.e. increasing species richness in already existing facilities to improve the quality of the provided services in general and increase the weight of regulatory services. The attention should be paid to increasing the diversity of species and communities. The increase in species diversity can be implemented in planned manner maintenance of existing plantations taking into account not only the tolerance of the selected species, but also in accordance with their functional role. This will contribute to the expansion of ecological niches of plantations and natural processes of diversification.

Keywords: nature based solutions; biodiversity; urban ecosystem; species composition; green spaces.

Introduction / Вступ

Urban green spaces perform a wide range of functions for community members both directly usable, utilitarian, and only perceivable, life-sustaining.

Utilitarian include recreational opportunities, as urban green areas offer people a place where they can relax, do some physical activities, socialize, and be in contact with nature. Major elements of urban green spaces – parks are also the centers of communities, providing venues for cultural events and festivities, strengthening identity and unity of community.

Life-sustaining involve supporting stability of urban ecosystem through a range of natural processes in the form of ecosystem services.

Object of research is the formation and provision of ecosystem services.

Subject of research is the management of green infrastructure for the support of their ecosystem services.

The ***purpose of research*** is to consider the opportunities and challenges for the growth of urban biodiversity as a way to support urban green spaces functions.

To achieve this purpose, the following main ***research objectives*** are identified:

- analyze the issues of ecosystem services provided by urban ecosystems;
- study the provision of ecosystem services by a range of Kyiv parks;
- compare the value of regulatory and cultural ecosystem services, provided by Kyiv parks;
- consider nature based and biodiversity solutions for the support of urban ecosystem services.

Analysis of recent research and publications. Ecosystem services at urban areas are considered in a variety of research works in multiple applications and in the form of case studies. Thus, a fundamental survey of ecosystem ser-

Інформація про автора:
Радомська Маргарита Мирославівна, канд. техн. наук, доцент, кафедра екології. **Email:** m.m.radomskaya@gmail.com;
https://orcid.org/0000-0002-8096-0313

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vices provided by green spaces of Stockholm was done by P. Bolund and S. Hunhammara [4]. This landmark publication covers such their services as air filtration, microclimate regulation, noise reduction, rainwater drainage, sewage treatment, as well as recreational and cultural values of urban areas. It was also among the first to conclude that the provision of ecosystem services must be embodied into the urban planning and land use decisions.

Being so important for the well-being of urban ecosystems, green spaces are still more often assessed in terms of their cultural service, as in the work by E. Andersson et al., M. P. Perring et al., E Gómez-Baggethun et al., T. Plieninger et al. Among those the research by E. Andersson et al. highlights the fact of interaction between humans and ecosystems in the production of ecosystem services [2]. A wide meta-analysis of 217 research papers dealing with urban ecosystem services showed a variety of tools used for valuation of services and lack of the implementation of findings into land use and planning solutions [9]. T. Mexia et al. stated that purposeful interventions of humans in urban ecosystems using green infrastructure in the form of nature-based solutions can help managers to optimize ecosystem services provision [15]. Moreover, investing in urban nature based solutions may often be economically advantageous, as it was shown by the extensive research conducted in 25 cities of the USA, Canada and China by T. Elmqvist et al. [5]. Researchers are sure about the importance of green spaces in the provision of ecosystem services [8], and health status of its citizens [17]. But growing pressure of population and infrastructure raises the need for some methods and techniques, able to support the provision of ecosystem services for citizens. This is relatively new field of theoretical and applied studies. However, some thoughts have already been expressed about the possibility to boost the complex of urban ecosystems services quality by novel components [10]. One of the important preconditions of the efficient improvements is clear differentiation of cultural and regulatory services provided by green spaces, since the latter one are of highest value for the stability and livability of urban ecosystem. This issue of differentiation is almost uncovered by modern research efforts.

Materials and methods of research. The quality of ecosystem services is hard to measure; therefore the quality of green spaces is used as a mirror for such assessment: health and integrity of plant communities are directly linked to the services integrity they provide.

For the purpose of the given research a range of Kyiv parks were assessed in terms of their ability to provide ecosystem services. At the first stage the factors having effect on the services formation were rated by the scale from 1 to 10 points, including:

- F1 – Area, covered with canopy;
- F2 – Diversity of species – trees, shrubs and grasses;
- F3 – Percentage of tolerant tree species (not vulnerable to heat extremes);
- F4 – Quality condition of communities;
- F5 – Areas available for expansion of green spaces;
- F6 – Presence of blue infrastructure;
- F7 – Number of bird species;
- F8 – Soil condition and percentage of paved surfaces;
- F9 – Quantity and diversity of lichens;
- F10 – Habitat unity (level of fragmentation).

The rating by each factor was awarded based on visual observations, literature and survey (for lichens community parameters and avian fauna). Lichen cover was evaluated at 50 trees chosen randomly within each park using the standard of lichen indication [16]. The number of bird species was defined based on 2 day observation, when all bird species seen in the morning hours along the 2 diagonal routes were counted. Identification of species was based on physical appearance and vocalization, using ChirpOMatic software.

At the second stage the contribution to the support of ecosystem services provision was considered from the perspective of cultural and regulatory services. The importance of green spaces for the real estate value, community well-being, recreation, sport activity and health of citizens is well known and praised. Therefore a gradual improvement of green spaces condition at the municipal territory was observed over the last five years. However, the majority of these improvements promote the cultural services of plant communities.

In order to conduct a rough estimation of the balance between regulatory and cultural ecosystem services provision, the studied parks were additionally weighted by pairwise matrix comparisons [13] according to their relative importance for either of the services groups. The scale used for this comparison includes values: 1/9 – 1/7 – 1/5 – 1/3 – 1 – 3 – 5 – 7 – 9 (from the minor to the most significant contribution in one of two groups of services. The principle of comparison is reflective assessment: each parameter is valued for the contribution to the type of services, so that the other receives its reverse value, for example, 6 and 1/6. The sum of the contributions was calculated separately for each group of services and the balance in percents of the total ability to provide ecosystem services was calculated.

The parameters for the contribution assessment were chosen based on the factors having influence on the overall quality of services provision, but which demonstrate clear divergence and support under certain conditions predominantly one type of services. The chosen parameters were provided with detailed rating from the highest to the lowest input into the benefits, received from green spaces. The list and the reference points of the parameters include:

- TR – Tree species – correlation between native and decorative species;
- FL – First level composition – natural grass cover of flower beds and lawns;
- B – blue infrastructure – natural and man-made water bodies or their absence;
- C – surface cover – canopy and grasses or paved or any other solid surface;
- L – landscaping – equipment and structures for passive or active recreation;
- RU – Intensity of recreational use – protected area or rarely visited area or intended for intensive recreation;
- A – landscapes anthropization – non-changed or modified communities;
- O – origin of community – root old or newly established community;
- S – surroundings – neighboring objects create limited technogenic pressure or high as industrial facility and infrastructure objects are around.

Research results and their discussion / Результати дослідження та їх обговорення

Urban ecosystem services issues. According to the Millennium Ecosystem Assessment (2003 and 2005), benefits from ecosystem services can be divided into four classes: cultural, provisioning, regulating and supporting services.

Cultural, provisional and regulating services work together to make ecosystems clean, sustainable, functional, and

resilient to change, but without supporting services, they wouldn't exist.

The formation of ecosystem services is driven by living organisms, – ecosystem service providers (ESPs). As a result the quality of ecosystem services depends on:

- Diversity and abundances of ESPs – species or populations of organisms – define the intensity and mode of natural processes and in this way – rates and essence of ecosystem service;
- Community interactions – structure aspects that influence how ESPs function in their natural landscape, such as compensatory responses that stabilize function and non-random extinction sequences which can erode it;
- Quality of key abiotic factors influencing the living activity of ESPs;
- Spatial and temporal fluctuations in the living activity of ESPs: daily and seasonal changes, etc.

As it is clear from the definitions, ecosystem services are closely interconnected with human activity, forming a sort of edge, at which people have to have these services in order to survive and at the same time, able to affect their provision (Fig. 1).

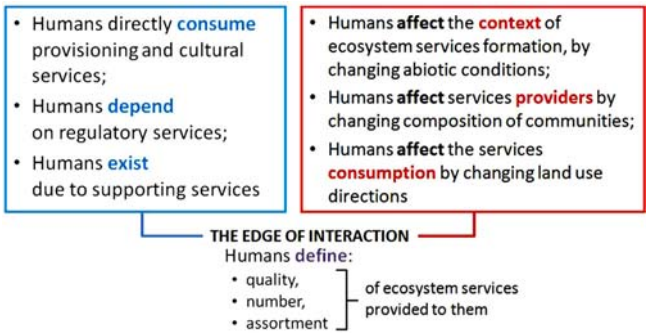

Figure 1. "Human-Ecosystem Services" interaction / Взаємодія "людина-екосистемні послуги"

The everyday human activity makes contribution to the degradation of environment components quality, changing the fundament on which ESPs exist. Additionally, the displacement or extinction of species as well as introduction of new species can drastically or gradually change the quality of ecosystem services provided. Moreover, people are able to modify the way ecosystem services provided by changing the landuse practices. This means that at the edge of their interaction people are able to define quality, number and list of ecosystem services provided. But the same means that humans are able to promote and support the provision of the existing and valuable ecosystem services.

Number and assortment of ecosystem services consumed by urban population is limited as compared to services offered by plant associations, since their primary purpose is rather non-material (Fig. 2).

Nevertheless, the same ecosystem services provided by both ecosystems are not always of the same quality. For instance, urban green spaces can work as habitats, but this will be very limited area and very specific conditions in terms of general quality and level of disturbance. Thus, it is suitable only for synanthropic species and accidental invasions from wild animals. This makes a paradox of human consumption: healthy, resilient and highly functional plantations are harvested, while semi-natural, lacking diversity and demonstrating poor self-regulation ability are supported within urban ecosystems.

The decreased quality of urban ESPs and services is due to man-made interventions, which strain the resilience of unban plant communities and reduce their functionability: increasing gaseous and dust pollution of air; special temperature and water conditions of air and soil; presence of stone, concrete and metallic surfaces, asphalt coverage of streets and areas; presence of underground communications and buildings in the area of root; additional illumination of plants in night-time; intensive mode of plantations usage.

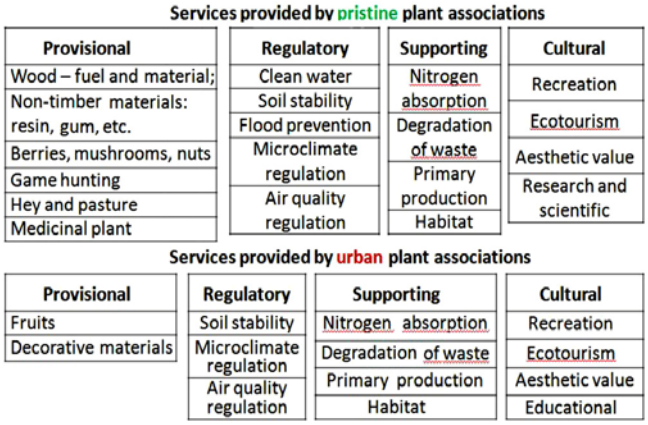

Figure 2. Ecosystem services provided by urban vs. pristine plant associations / Екосистемні послуги, що надаються міськими та природними рослинними угрупуваннями

The global threats to urban green spaces viability are superimposed on the mentioned local threats typical for urban areas. This is mostly related to climate changes, which involve increasing temperatures, sharp seasonal transitions and changed rainfall patterns; and initiate intensified natural disasters, new pests and diseases, as well as new competing species arrival. Still, climate change is both the issue to be tackled and the issue, which put obstacles on the way to solution.

In the context of accelerating climate change, it is regulatory services that need to be focused on, or given the highest priority at urban areas. This is the only way to protect all other services. In fact, the regulatory services provided by plant associations are transformed into adaptation services – extremely needed in urban conditions. Adaptation services are the ecosystem process, which provide adaptation to changing environment conditions by mitigation of negative factors and impacts.

Benefits provided can arise from either keeping ecosystem in as close to initial condition as possible, or from new opportunities, formed due to transformation of ecosystems in accordance with new conditions.

Thus, there is need to solve two issues: support the ESPs at urban areas and increase the quality of services provided, as well as promote the regulatory services provision, which are of highest importance.

Results. The study was conducted in 15 parks of various types: residual native forests, urban forests transformed by human activity, man-made parks. The survey didn't include squares and other forms of minor green spaces. The results of rating (Tabl. 1) demonstrated generally higher ability of vast green spaces to provide ecosystem services. However, smaller areas are not always completely outcompeted: those which have solid green cover or water body with natural plant communities (e.g. Rainbow Park, Rusanivska embankments, Telbin Park) are also efficient.

However, the complex of services provided by each parks may be quite different. The corresponding assessment using pair-wise matrix comparisons (Tabl. 2) was conducted and the results were transformed into percentages of general rating of services provision (Fig. 3). It has showed that value of regulatory services weighted out the cultural

ones in those parks, which have root communities of predominately local species, with grassy and arboreal associations having similar importance. The presence of blue infrastructure contributes to both groups of services, but is also considered a balancing factor depending on the origin and general condition. At the same time, parks created for recreation have very limited contribution to the regulatory services, since their design and communities structure account very few environmental considerations. Thus, the improvement of some of the design solutions and less intensive landscaping in favor of recreation would bring some additional benefits in the form of additional quality and quantity of ecosystem services.

Tabl. 1. Rating of the selected parks by their ability to provide ecosystem services / Рейтинг обраних парків за наданням екосистемних послуг

Park name	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	Total rating
Aurora = 7.91 ha	2	2	3	4	1	1	3	2	3	2	**23**
Desnyansky park = 9.67 ha	4	3	4	4	1	1	4	5	4	2	**32**
Dolobetsky island = 98 ha	8	8	4	7	1	10	9	8	8	7	**70**
Gorbachiha = 80.3 ha	9	9	6	8	1	10	10	9	9	9	**80**
Hydropark = 365 ha	8	8	4	7	1	10	9	7	8	8	**70**
Kyoto park = 13.4 ha	4	4	3	6	1	1	3	4	3	2	**31**
Malyshka and Popudrenko = 28.95 ha	4	3	4	4	1	1	3	3	2	2	**27**
Muromets = 219 ha	7	7	4	7	1	10	9	7	8	7	**67**
Partisan Glory Park = 111.9 ha	7	6	5	7	1	7	7	7	7	5	**59**
Shukhevych and Water Park = 23.3	4	4	4	5	1	5	5	5	4	3	**40**
Rainbow park = 32.8 ha	6	6	4	7	1	7	6	6	6	6	**55**
Rusanivsky embankment = 28.9 ha	6	5	5	5	1	7	6	6	6	4	**51**
Telbin park = 25.8 ha	6	6	4	7	1	7	6	6	6	5	**54**
Trukhaniv island (south to the Northern bridge) = 121 ha	9	8	4	7	1	10	10	8	8	8	**73**
Victory Park = 66.09 ha	7	5	5	6	1	7	6	6	6	5	**54**

Tabl. 2. Weighting of the value of regulatory and cultural services from green spaces / Вага регулюючих та культурних послуг від зелених насаджень

Parks	Type of service	TR	FL	B	C	L	RU	A	O	S	Sum
Aurora	R	1/6	1/3	0	1	1/6	1/9	1/9	1/6	1/6	2.22
	C	6	3	0	1	6	9	9	6	6	46.00
Desnyansky park	R	1/6	1/3	0	3	1/6	1/9	1/6	1/6	1/3	4.44
	C	6	3	0	1/3	6	9	6	6	3	39.33
Dolobetsky island	R	9	6	9	6	6	6	6	9	9	66.00
	C	1/9	1/6	1/9	1/6	1/6	1/6	1/6	1/9	1/9	1.28
Gorbachiha	R	9	9	9	9	9	9	9	9	9	81.00
	C	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1.00
Hydropark	R	9	6	9	6	3	1	6	9	3	52.00
	C	1/9	1/6	1/9	1/6	1/3	1	1/6	1/9	1/3	2.50
Kyoto park	R	1/9	1/3	0	1	1/6	1/9	1/9	1/6	1/9	2.11
	C	9	3	0	1	6	9	9	6	9	52.00
Malyshka + Popudrenko	R	1/6	1/3	0	3	1/6	1/9	1/9	1/6	1/9	4.17
	C	6	3	0	1/3	6	9	9	6	9	48.33
Muromets	R	9	6	9	6	3	3	6	9	3	54.00
	C	1/9	1/6	1/9	1/6	1/3	1/3	1/6	1/9	1/3	1.83
Partisan Glory Park	R	6	6	3	6	3	1	3	6	1/9	34.11
	C	1/6	1/6	1/3	1/6	1/3	1	1/3	1/6	9	11.67
Shukhevych + Water Park	R	1	1/3	6	3	1/6	1/9	1/6	1/3	1/6	11.28
	C	1	3	1/6	1/3	6	9	6	3	6	34.50
Rainbow park	R	9	6	6	6	6	9	6	6	6	60.00
	C	1/9	1/6	1/6	1/6	1/6	1/9	1/6	1/6	1/6	1.39
Rusanivsky embankment	R	6	6	9	3	3	3	1	9	1/3	40.33
	C	1/6	1/6	1/9	1/3	1/3	1/3	1	1/9	3	5.56
Telbin park	R	3	1	9	1	1/3	1/6	3	3	3	23.50
	C	1/3	1	1/9	1	3	6	1/3	1/3	1/3	12.44
Trukhaniv island	R	9	6	9	6	6	3	6	9	3	57.00
	C	1/9	1/6	1/9	1/6	1/6	1/3	1/6	1/9	1/3	1.67
Victory Park	R	6	3	3	3	1	1/3	3	6	1/6	25.50
	C	1/6	1/3	1/3	1/3	1	3	1/3	1/6	6	11.67

Note: R – contribution to regulatory services; C – contribution to cultural services.

Recommendations. The main challenges for green spaces, seen to a slightly different degree in all parks were:

- expansion of residential areas;
- diseases of trees;
- drying of trees and earlier senescence of leaves;
- intensive recreation activity;
- excessive cutting of branches on trees;
- considerable level of air pollution due to location in capital city;
- lack of soil humidity;
- tramping of soils, which reduces their filtering ability;
- low diversity of communities;
- domination of trees with low tolerance to fluctuation of abiotic parameters.

In the face of climate changes these issues become more important and turn into urgent problems. The new approach to adapting urban areas to climate change is by the expansion of green and blue infrastructure – so called nature based solutions.

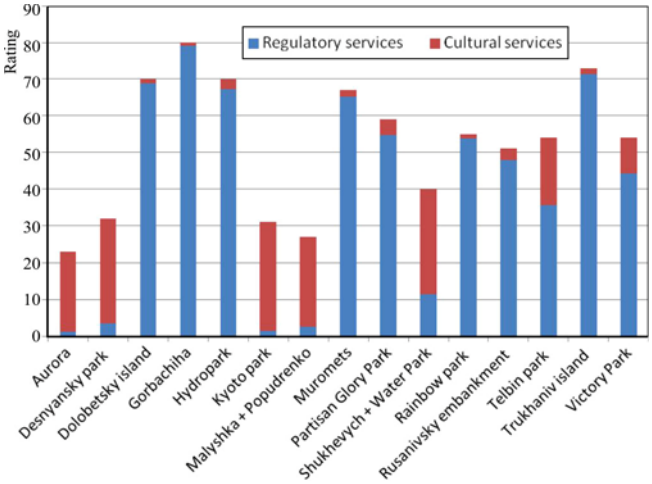

Figure 3. The balance of regulatory and cultural services provision by the parks / Баланс регулюючих та культурних екосистемних послуг парків

Nature-based solutions (NBS) refer to the sustainable management and use of nature for tackling socio-environmental challenges, like climate change, water pollution, etc. They are also considered a contributor to ecosystem services provision.

These solutions are inspired and supported by nature, they are cost-effective, provide complex environmental, social and economic benefits and help build resilience. There is a wide variety of possible solutions, which could be combined into the following groups: greening interventions; public green spaces; vertical greening; green roofs; water sensitive urban design measures; river restoration; measures of bioengineering. Some of them are hard to implement, but still efficient, like greening interventions and public green spaces, while others seem to give good results under the conditions of limited spaces available, which is a problem for any city.

Thus, a range of limitations of NBSc must be accounted:

- green spaces expansion is not equal to supporting ecosystem services, as their provision is foremost dependant on the level biodiversity;
- spatial aspect is still important, as it is obviously defining factor for possible emergent effect of green infrastructure development. Smaller area support less biodiversity and thus cannot provide wide spectrum of services;
- new green areas can be still mostly monocultural and strongly dependent on human maintenance;
- new greenery is of functional type and mostly serves human needs instead of natural balance.

Moreover, all the parks involved in the research have no additional space for further expansion, except vertical surfaces, which the case outside the parks. So, if the ecosystem services are to be the aim of interventions, these must be approached with biodiversity based solutions. These solutions intend to increase the diversity of species and communities and thus increase overall resilience of urban ecosystems. Thus, nature based solutions will increase in the number of ecosystem services providers, while biodiversity based solutions enhance ecosystem services quality.

The diversity should be developed at multiple levels and not be limited to only to planting new species of plants. Diversity of communities is also an important component of the process. The latter can be performed as a continuation of species diversity improvement or as a complex of actions aimed at inventory and protection of the existing ecosystems, which demonstrate mosaic character. In terms of the city of Kyiv, these are lake ecosystems, which have area over 0.5 km^2. For example, Lake Almazne (1.65 km^2) in the northeastern part of the city encloses such distinctive communities: peat bogs with peat vegetation and animals; swamp forest with willow and other deciduous moisture-resistant species; circular birch plantations in drier conditions; pine forest with dry sandy soils; swamp; and sand dunes. Lake Radunka (0.8 km^2) and Minister (0.45 km^2) are smaller, but also have diverse communities: wetland with swampy vegetation; willow thickets with other deciduous moisture-resistant species; mixed forest plantations in relatively dry conditions and sand embankments. These lakes are man-made, but based on natural preconditions and thus have attributes of self-regulated natural communities. But active recreational development of their resources compromises their ability tj perform high-quality ecosystem service of such a great importance for urban residents.

To support the diversity of communities the following approaches are valid:

- Conservation of natural grassland communities around urban areas and creation of green parking areas, as well as green roofs and sport facilities with grass covers, as they increase diversity of landscapes, reduce thermal pressure and provide habitat for insects-pollinators and food source for birds.
- Creation of wetlands and expanded floodplains in addition to arboreal communities to provide habitat for urban fauna and recreational opportunities.
- Improvement of connections between the existing areas in order to reduce fragmentation, increase core parts of associations and reduce the level of disturbance inside them.
- Development of blue infrastructure (restoration of rivers, formation of retention ponds, recreational water facilities) will offer new ecological niches and thus forms new communities.
- Expansion of areas free from infrastructure, as they tend to house small, but diverse communities.

Additional opportunities for species and communities diversity arise from climate changes, since initiated successions and shifting habitats could contribute to increasing diversity of landscapes.

Going back to species diversity, efficient development of richness at this level must be based on changing overall principles of green infrastructure management. The most important of this is shifting from the decorative and geometrical principles of green spaces design to choosing species of higher diversity, resilience and preferably with foundation or engineering functional potential, as it will create new niches. This will affect not only the new sites, but also the existing ones, since the substitution of losses due to sanitary or emergency cutting could be based on diversification, instead of visual uniformity and order. Attention should be also paid to the improvement of habitat potential of park for avian fauna, since birds are almost the only and exclusive group of animals, which can efficiently coexist with humans in cities and thus perform their seed dispersal and other ecological functions.

Discussions. There is a lack of clear knowledge about the regularities in the system "urban biodiversity and ecosystem functioning", which is necessary for their management [14]. And species richness cannot be considered the only basis of the ecosystem services formation [9, 1]. Moreover, relations between the ecosystem services must be ac-

counted as an important driver of their formation and delivery, and consequently attention to only one service might damage the quality of others [3]. However, most of the authors agree on the fact that biodiversity supports the resilience of ecosystems, which is the core for urban ecosystems [14, 3, 7, 6]. The diversity of both species and communities is argued to be the top priority for all solutions [18].

So, based on the results of the work performed, it is possible to formulate the following scientific novelty and practical significance of the research results.

Scientific novelty of the research is in the formation of the concept of biodiversity based solutions to support the ability of green spaces to provide ecosystem services and increase the efficiency of the functioning of the urban ecosystem.

Practical significance of the research results – the implementation of the developed recommendations for the growth of urban biodiversity within green spaces will help maintain viability of plant associations and their role in protection of urban environment, as well as improve quality and assortment of ecosystem services provided.

Conclusions / Висновки

1. Urban ecosystems combine man-made and residual natural objects, which have to work on provision of ecosystem services for all urban population. People and living organisms interact in the process of formation and consumption of ecosystem services, since humans are able to define the context and assortment of ecosystem services they consume. This is especially seen in the case of green spaces.

2. The number and quality of ecosystem services by plant communities depend on a number of factors and the potential of urban parks of the Kyiv city to provide them was evaluated using score assessment. The results showed the highest ability to provide ecosystem services is typical for bigger parks and those with integral green plantations and blue infrastructure.

3. The relative contribution of the same parks to regulatory and cultural ecosystem services was weighted by pair-wise matrix comparison. This has also demonstrated the biggest value of regulatory services for the parks with root communities of predominately local species. However, those parks intended mostly for recreation and having few environmental solutions included, may improve their potential to provide the regulatory services by implementation of special actions.

4. Nature-based solutions offer a wide range of opportunities, but have limited implementation within densely populated cities. Biodiversity based solution might be a good option in case of lacking space and poorly designed green spaces. The diversity solutions must be implemented at both species and community levels.

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М. М. Радомська
Національний авіаційний університет, м. Київ, Україна

ПІДТРИМКА ЕКОСИСТЕМНИХ ПОСЛУГ МІСЬКИХ ЗЕЛЕНИХ ЗОН ЗБІЛЬШЕННЯМ БІОРІЗНОМАНІТТЯ

Урбоекосистеми характеризуються зниженням якості та деяких екосистемних послуг, що надаються біотопом та екотопом міста, хоча попит на них підвищений. За таких умов існує потреба підтримати процеси надання екосистемних послуг на належному рівні. Показано, що якість та асортимент екосистемних послуг, що надають природні рослинні асоціації та міські зелені насадження, істотно відрізняються. Здійснено ефективне оцінювання потенціалу та якості надання екосистемних послуг парками лівобережної частини міста Києва. На першому етапі роботи оцінено потенціал надання послуг за десятьма критеріями. На другому етапі встановлено співвідношення між культурними та регулювальними екосистемними послугами, що надаються парками, за допомогою попарного зваженого оцінювання. Встановлено, що найбільший потенціал надання екосистемних послуг у місті мають великі малозмінені лісопарки та озерні екосистеми, при цьому значну частину наданих послуг становлять саме регуляторні, а не культурні. Розглянуто можливості для покращення надання екосистемних послуг у містах за допомогою природних рішень та з'ясовано їх можливості обмеження. Запропоновано зосередити увагу на рішеннях, які ґрунтуються на збільшенні біорізноманіття, що за умов просторового обмеження дає реальні засоби для покращення ситуації на довгострокову перспективу. Доцільно приділити увагу збільшенню різноманіття видів та угруповань завдяки створенню або реконструкції водно-болотних угідь, водних об'єктів і трав'яних комплексів як у межах міст, так і на його околицях. Встановлено, що облаштування об'єктів активного відпочинку не робить позитивного внеску у функціональність зелених зон як чинників регуляції якості довкілля в місті. Рекомендовано отримати передумови надання екосистемних послуг під час створення та реконструкції об'єктів зеленої та блакитної інфраструктури міста. Надано рекомендації щодо зміни видів структури вже наявних зелених насаджень. Показано, що підвищення видового різноманіття можна реалізовувати планово під час обслуговування наявних насаджень з урахуванням не тільки толерантності вибраних видів, а й відповідно до їх функціональної ролі. Це сприяє розширенню екологічних ніш насаджень і природним процесам урізноманітнення угруповань.

Ключові слова: природничі рішення; біорізноманіття; урбоекосистема; видовий склад; зелені насадження.