Ecosystem services of urban forests: conceptual approaches

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Abstract. Conserving and restoring ecosystem services in urban areas can reduce the environmental impacts and ecological debts of cities, while improving the resilience, health and quality of life of their inhabitants. Green and natural areas of cities fulfil important functions in shaping a comfortable environment, despite this, the design, creation and maintenance of green spaces should also take into account certain risks associated with their possible unfavourable impacts. The article reveals the ecosystem services of urban forests of the urban system. Their characteristics are given. The risks for the effective implementation of the ecosystem services approach in territorial planning are disclosed. Using an approach to ecosystem services in planning can help policy makers move from policies on individual issues, such as the creation and maintenance of green infrastructure, to the formation of an integrated policy that recognizes the services provided by green infrastructure. Accounting for ecosystem services at the planning stage is much more cost-effective than covering the costs of loss or restoration of ecosystem services in the future.

1 Introduction

The scientific problem under consideration lies at the junction of the already fundamental scientific disciplines: social ecology and plant ecology. Its step-by-step solution requires a comprehensive approach, taking into account the peculiarities of woody plant growth in urbanised environments. The growing conditions of green spaces in urban areas differ sharply from natural growing conditions. A variety of harmful factors are characteristic of urban environments. They affect the condition of green spaces, causing physiological disorders and damage to plants, which in turn leads to a reduction in the life cycle of urban green spaces.

In turn, green spaces can significantly transform the conditions of the urban environment, and this transformation can go in both favourable and unfavourable directions for the urban population. The concept of ecosystem services is currently one of the most actively developing areas of modern world science.

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Since the publication of two key collective papers, Millennium Ecosystem Assessment [1] and The Economics of Ecosystems and Biodiversity [2], the valuation of ecosystem services has become an important research trend [3].

Urban forests have recently attracted the attention of researchers from various disciplines and governments at many levels. Of course, the aesthetics and symbolism of trees have long been a subject of municipal planning.

However, the surge of interest in urban forests goes beyond mere aesthetics. Modern urban forest planning is based on the idea that urban forests provide the necessary green infrastructure to combat pollution and other environmental quality problems in urban areas.

In addition, foresters have recognised that urbanisation is an important factor affecting the ability of trees to play a role in societal adaptation and mitigation of climate change. This trend is attracting scientific and economic aspects of ecosystem services [3].

Ecosystem services are the benefits that humanity derives from ecosystem functions, or the direct and indirect impacts of ecosystems on human well-being. Thus, the concept of ecosystem services seeks to identify and value the diversity of linkages between human society and the environment in the most comprehensive way possible [4].

As part of preparations for the Year of Ecology in the Russian Federation, in December 2016, a list of instructions from the President of the Russian Federation was approved at a meeting of the State Council on "On the ecological development of the Russian Federation in the interests of future generations".

One of the directives (Pr-140GS, item 1 e) emphasized the necessity of formulating a comprehensive action plan to bolster Russia's influence in shaping the international environmental discourse. This involves not only participating in global dialogues on sustainable practices but also engaging in discussions on establishing a compensation framework for ecosystem services. This framework would recognize Russia's pivotal role as a global environmental donor, underscoring its commitment to environmental stewardship.

The United Nations Sustainable Development Goals for 2016-2030 (Transforming our World..., 2015) highlight the significance of ecosystem services, particularly in Goals 11, which focuses on creating sustainable cities, and 15, which aims at conserving terrestrial ecosystems. These goals serve as a universal mandate, urging countries to integrate ecosystem services into their development agendas.

Within the OECD framework for economic advancement, there's a strong focus on fostering green growth, which inherently involves the preservation and enhancement of ecosystem services (Putting Green Growth, 2013). Additionally, the World Bank has actively integrated the economic valuation of ecosystems into its project portfolios, recognizing the fundamental role these services play in sustainable development (World Bank..., 2021). Similarly, the European Community outlines the importance of ecosystems and their services in its strategic documents, setting the course for the region's economic trajectory towards 2050, with a marked emphasis on green economy principles (Towards a Green Economy..., 2013) [5-10].

For Russia, tailoring ecosystem service assessment methodologies is imperative, given that existing models largely derive from contexts pertinent to Europe and the United States. These regions differ considerably from Russia in terms of natural conditions, research depth, and the availability of high-resolution primary data.

The current landscape of research on urban ecosystem services in Russia, including those provided by urban forests, is considerably underdeveloped. Existing studies are predominantly focused on the evaluation of especially protected areas within urban limits and adapting foreign methodologies to the Russian context. Developing tailored approaches to thoroughly assess ecosystem services in Russian cities is crucial, as it will provide a better understanding and management of urban natural resources, ultimately contributing to enhanced urban resilience and sustainability

2 Materials and methods

The adaptation of the concept of ecosystem services to the conditions of Russian cities is a multifaceted process that includes several key stages. First of all, it is necessary to develop a classification system for ecosystem services specific to Russian cities. This will require the study and integration of world experience, taking into account Russian legislative peculiarities, unique features of Russian cities and existing domestic experience in the classification of natural functions and ecosystem services.

At the second stage, it is necessary to study international experience in the assessment of ecosystem services of urban forests. This will help identify the most effective approaches and methods that can be applied in the Russian context to improve the quality of life in cities and preserve their natural heritage.

The third area of work will be the study and analysis of the Russian experience in assessing the functions of urban ecosystems. It is important to take into account how Russian experts and scientific institutions approach the issue of evaluating and managing these resources in order to identify the strengths and weaknesses of current approaches.

Fourth, it is important to identify the best methods for assessing the ecosystem services of urban forests. This includes finding the most effective and accessible monitoring and analysis tools that will take into account both international best practices and national specificities.

Thus, adapting the concept of ecosystem services to the conditions of Russian cities will require an integrated and multilevel approach that takes into account both international experience and the unique characteristics of Russian territories. This will create a sustainable ecosystem services management system that contributes to the improvement of the urban environment and the preservation of natural potential for the benefit of current and future generations.

The following methods were used to write the paper: systematic, comparison and generalisation.

3 Results of the research

A significant amount of research on ecosystem services seeks to identify the potential use of ecological systems to improve the quality of life and human well-being.

These publications deal with the growing environmental, social and economic dependence of mankind on these services and the comprehensive use of a systems approach in balancing the management of complex socio-ecological-economic systems.

Such systems include the urban system, which is a complex, structurally integral and relatively independent system, and is considered in the interrelation and interdependence of such subsystems as economic, social, legal, demographic.

Ecosystem services are all the useful resources and benefits that humans can obtain from nature. Ecosystem services are the fundamental human needs for habitat and food, and therefore directly affect our standard of living.

The UN Millennium Ecosystem Assessment [1] explicitly refers to ecosystem services as "the direct and indirect contribution of ecosystems to human well-being".

Knowledge about ecosystem services is necessary for people to understand how important it is in their lives to conserve biodiversity and maintain natural processes in the environment. Most civilizations of the past ceased to exist for environmental reasons.

Even famous civilizations like Maya, Easter Island disappeared after making the place they lived in unfit for human life. Nature ceased to provide for human welfare and the brilliant successes in architecture, science and state former civilizations turned to desolation and ruins.

For the same reasons, the majority of modern Third World countries live in poverty.

In Russia, which has a huge wealth of ecosystem services, they do not always realize the simple truth: nature protection is an investment in their own well—being. Research on ecosystem services plays a key role in making decisions that can affect the state of natural ecosystems. After all, it is the preservation of ecosystems, their components and biodiversity in general that determines people's economic opportunities and standard of living.

Over the past decades, there has been an increase in the number of studies revealing the deep relationship between the presence of green spaces surrounded by people and their perception of overall health and well-being. With the acceleration of urbanization and increasing urban density, these natural oases are increasingly recognized for their critical role in improving the quality of life.

The benefits of accessible green spaces extend far beyond simple aesthetics, becoming essential elements of public health infrastructure. Research consistently shows that regular access to safe and local green spaces, whether parks, public gardens or tree-lined streets, not only increases physical activity levels, but also has significant positive effects on mental health. These spaces create a haven for sports, reducing obstacles to activities such as walking, running or cycling, thereby improving cardiovascular health and reducing the risk of obesity and related diseases.

In addition, green areas provide psychological and emotional benefits that are becoming important in modern dynamic life. The calming effects of nature help to reduce stress, anxiety and depression, providing urban residents with a much-needed respite from the constant irritants of the urban environment. This connection with nature is especially useful for developing mindfulness and a sense of inner peace, which is critically important for maintaining mental stability.

Beyond personal health, green spaces also promote social interaction and community strengthening. These zones often turn into community centers where people gather, communicate and interact with each other, which strengthens a sense of identity and belonging, as well as promotes social cohesion and cooperation.

In light of these findings, urban planners and policymakers are increasingly advocating for the integration of green spaces into cityscapes as a strategic component of urban development. By prioritizing the expansion and maintenance of green areas, cities can not only bolster public health outcomes but also create more attractive and sustainable environments that enhance the overall quality of urban life. As the research continues to unfold, the importance of investing in green infrastructure as a catalyst for individual and collective well-being becomes ever more apparent. [6-8].

Green infrastructure can provide an excellent opportunity for physical activity that is lacking in industrialised countries. When the landscape encourages physical activity, it provides valuable benefits to humans. The economic value of physical activity is high.

It is now clear that a society that invests in protecting biodiversity will reap dividends not only from a clean environment, but also in terms of good health, rising property prices, the arrival of new talented people in the regions who will use and store these services and thereby contribute to the economic development of villages and towns.

In general, several areas of practical application of ecosystem service valuation have emerged, the main ones being the use of the results: in national systems of integrated ecological and economic accounting; in the development of national environmental policy and long-term programmes and plans for environmental protection and nature management (selection of directions for environmentally sound development and reduction of environmental threats); for setting payments for ecosystem services, as well as in the formation of markets for ecosystem services; and in the development of ecosystem services.

Significant progress has been made in identifying, quantifying and valuing the ecosystem services of urban ecosystems [6], but this knowledge remains largely unrealised in urban planning and management.

Among the UN indicators of sustainable development, forest cover is considered an indicator related to economic sustainability, which can be correlated with ecosystem services.

Green infrastructure is a factor in ensuring the sustainable development of the city, and greening indicators (provision of plantings, condition and persistence of plantings in the urban environment) are included in the group of indicators of sustainable development [9].

The main function of the green infrastructure of the urban system is the maximum reduction of anthropogenic impact and strengthening the influence of the natural potential of the city, focusing on the ecological significance of the territory, considering the whole range of landscape changes.

Based on the generally accepted approach, and taking into account the complex (ecological, economic and social) functions of green spaces, we present the main ecosystem services of urban green spaces as follows (Fig. 1).

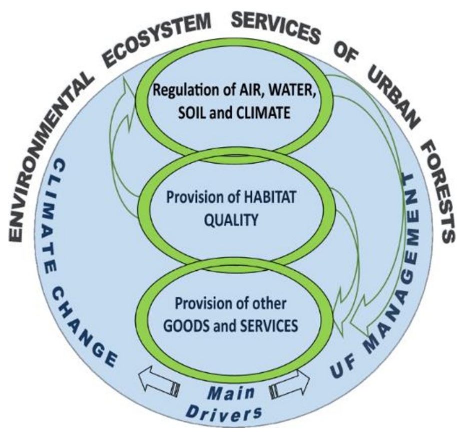

Fig. 1. Type, linkages and main drivers of ecological ecosystem services of urban forests [10].

Calculating the dynamics of ecosystem service values coupled with land use dynamics would prevent unbalanced decisions regarding the future development of an urban area.

Strict regulation of the urban planning indicator-greening level as an additional urban planning constraint, which would contribute to the preservation of existing ecostabilisation spaces, seems to be an effective practical move.

The interdepartmental nature of the problem poses a certain risk to the effective implementation of the ecosystem services approach in spatial planning.

4 Conclusion

Thus, the transition from an ecological basis for assessing the impact of economic calculations requires not only careful monitoring but also, above all, an appropriate database. Taking into account the latter and from the point of view of the universality of the calculations, we believe it is reasonable to use the transfer method to calculate the total value of ecosystem services for different types of land use at the first stage of integrating the approach of valuing ecosystem services of urban ecosystems in urban master planning. The same approach will provide comparable results and track relevant changes, which will serve as a basis for refining forward-looking urban plans. The sources of data can be materials of master plans of cities (provided they are up-to-date and of sufficient quality), standard statistical land survey forms on land distribution of territorial-administrative units and available satellite data. It is necessary to integrate landscape planning, which serves as a basis for sustainable development planning, into urban planning in Russia. Urban planning should prioritise the preservation of natural landscapes and their properties. We consider it appropriate, by analogy with forest cover, to use the indicator "the level of urban greening" to justify the environmental component of urban development in the general planning of urban areas.

Ecosystem services play a crucial role in optimising the quality of life in cities. Urban forests can reduce air pollution and greenhouse gas emissions, sequester carbon, regulate air temperature, mitigate stormwater runoff, reduce noise, and provide recreational, social, psychological and aesthetic benefits. Introducing the concept of ecosystem services into spatial planning will ensure effective inter-agency coordination between environmental and urban planning agencies.

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