

Conceptual Framework of Adaptive Transformation of Green Areas in Accordance with the Social Load on Urban Space

JSACE 1/39

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Received
2025/09/30

Accepted after
revision
2025/01/09

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<https://doi.org/10.5755/j01.sace.39.1.42933>

The relevance of the study is determined by the increasing social load on urban green areas, which serve as one of the key components of the ecological and social infrastructure of contemporary cities. The purpose of the paper is to ground the conceptual approaches to the adaptive transformation of green zones in urban space in Ukraine in accordance with social load, taking into account key influencing factors, load levels, and algorithms for managing spatial change. The research methodology is based on a systemic approach, methods of structural and functional analysis, comparative typology, and elements of graphical visualization. The main social factors that determine the nature of the load on urban green areas were identified. A generalized model of adaptive transformation of green spaces was suggested, it reflects the relationship between the degree of social load and the level of spatial changes. An algorithm for managing spatial transformations was developed, it has five stages: analysis, identification of load level, determination of adaptation directions, implementation of changes, and monitoring. The suggested tools make it possible to adapt urban areas to the dynamic changes of societal needs and increase the efficiency of their usage. The research findings can be applied to strategic urban development planning, the development of public services improvement programmes, and the formation of inclusive solutions for urban space in modern cities in Ukraine and the world.

Keywords: green infrastructure; public services improvement; recreational needs; social factors; spatial transformation management; Ukraine.

Abstract



Journal of Sustainable
Architecture and Civil Engineering
Vol. 1 / No. 39 / 2026
pp. 115-128
DOI 10.5755/J01.SACE.39.1.42933

Introduction

Problem Statement. Green areas in urban spaces play a multifunctional role, performing ecological, recreational, health and socio-cultural functions. They contribute to reducing anthropogenic pressure on the environment, create comfortable living conditions and provide opportunities for the integration of different social groups. At the same time, modern urbanization processes are accompanied by the increase of social load on green areas, i. e. population increase, increased transport mobility and a growing need for accessible recreational spaces. This leads to an imbalance between social needs and the ability of existing green areas to meet them without losing their ecological and cultural value.

Traditional models of green space management do not provide adequate adaptability, as they are largely focused on static parameters of spatial planning. In international discourse, the problem is being solved through the concepts of sustainable cities and sustainable urban development, which involve integrating natural components into the urban frame, developing green infrastructure and taking into account the dynamics of socio-demographic changes. These approaches are reflected in the key strategic documents, particularly in the European Green Deal (EU Green Deal), the New European Bauhaus initiative (NEB), and the UN Sustainable Development Goal 11 – Sustainable Cities and Communities.

Therefore, the research problem is to find principles, models, and practical tools for the adaptive transformation of green areas in urban space that are able to ensure the balance between environmental sustainability and social efficiency. The solution of this problem has an interdisciplinary significance. From the theoretical point of view, it is important in the context of the development of modern concepts of urbanism and landscape architecture; from the practical point of view, it helps to develop urban environment management strategies aimed at long-term sustainability, inclusiveness, and compliance of Ukrainian cities with European and global standards of sustainable development.

Analysis of Research Literature. The analysis of scientific papers dedicated to the problems of adaptation and transformation of green areas in urban space states that the researchers both in Ukraine and abroad are paying increasing attention to the problems of sustainable development, inventorying green spaces, and the role of green infrastructure in shaping qualitative urban environment.

The issues of urban improvement, greening and the creation of green infrastructure in the context of sustainable urban development are discussed in scientific papers by the researchers affiliated with regional institutions. Having analysed global practices of public administration in the field of urban improvement, Zadorozhnia, (2021) emphasised the importance of using international experience to improve national approaches. In their study, Sokolan and Kucherenko (2021) analysed the practice of planning residential areas during reconstruction, highlighting the need for a systems approach to urban improvement and the integration of green spaces into the urban spatial structure.

Such researchers as Svashenko and Prokopenko (2024) studied the problems on optimising the structure of green spaces in conditions of anthropogenic pressure, which emphasises the relevance of ecological approach to urban environment management. At the same time, Bondarenko (2025) examined the peculiarities of forming a green space system in the city of Dnipro and emphasised the need for a complex planning. He focused on the development of landscape architecture in the context of transformation of modern cities, defining it as an important component of sustainable development.

Shyshchenko et al. (2021) focused their attention on the accessibility of green areas to inhabitants, especially in compact cities, which is of great importance for improving the quality of life of residents. At the same time, Zibtseva and Yukhnovskyi (2019) conducted an analytical assessment of the current norms for urban greening, emphasising the need to adapt them to modern

needs. Zibtseva (2018) also considered the specifics of greening in densely built-up areas of cities, emphasising the importance of compliance with state building standards.

Researchers based in Ukraine are making a significant contribution to the development of green urban ecosystem concepts. In particular, Orlovska and Pavlenko (2024) summarized the main theoretical approaches to the formation of green urban ecosystem, defining it as a key direction for sustainable urban development. Meanwhile, Bakova and Karpinskyi (2022) focused their attention on the inventory of green spaces in the street and road network in Odessa, emphasizing the importance of accurate accounting for effective management. In their study, Zhuk and Myshiliuk (2025) demonstrated the possibilities of using GIS technologies for accounting of green spaces in the city of Chernivtsi. At the same time, Kiseliiov and Kiseliiova (2021) considered public spaces as an effective tool for reconstructing urban environment.

The researchers working inside the region pay significant attention to practical research cases and the adaptation of green zones in urban space using the examples of such Ukrainian cities as Odesa, Chernivtsi, Dnipro, Kyiv and others, as well as the possibilities of applying the suggested approaches to the transformation of modern Ukrainian cities.

The researchers from international consortiums also pay considerable attention to this topic. For example, Bibri et al. (2020) studied the cases of forming compact cities as a strategy for achieving sustainable development goals. Semeraro et al. (2010) considered a green space to be a factor of environmental stability and a source of social benefits for the population. Conversely, Hansen et al. (2019) focused their attention on the concept of multifunctional green infrastructure for compact cities.

Elbakidze et al. (2023) analysed the interaction of residents with green areas in Eastern European cities. They revealed the socio-cultural aspects of urban spaces usage. Jang et al. (2020) suggested the «Urban Green Accessibility Index», which provides a quantitative assessment of the accessibility of green areas to the population. The overall analysis showed that international practice offers more complex tools for evaluating the accessibility of urban green spaces.

Thus, researchers working both inside and outside the region pay significant attention to the issue of greening and the development of urban green infrastructure, as it includes management, environmental, social, and technological aspects. The generalised analysis showed that international practice offers more comprehensive tools for assessing the accessibility of urban green spaces. In general, the above studies form a scientific basis for further development of the concept of adaptive transformation of green areas in accordance with the social load on urban space.

Identification of Unsolved Aspects of the Overall Problem. Despite the increasing attention to the development of urban green areas, several issues have not been studied yet. In particular, there is a lack of systematic approaches to identifying the factors that determine socio-cultural load, as well as to analysing their integrated influence on the state and functioning of green areas, especially in conditions of war.

Furthermore, adaptive models designed to ensure the correspondence between spatial organisation of green areas and various levels of social load have not been developed enough. Management practice lacks algorithmic tools which could ensure the continuity of adaptation process, including monitoring and timely correction of decisions made.

These aspects remain overlooked mainly due to the complexity of comprehensive analysis of socio-spatial processes and the restrictions of existing methodological approaches. Addressing these gaps will make it possible to reach a higher level of scientific understanding of the existed problem and contribute to the development of effective strategies for managing urban green areas.

Purpose and Objectives of the Study. The purpose of the research paper is to develop scientifically

grounded approaches to the adaptive transformation of green areas in urban spaces according to social load in accordance with social load, taking into account key influencing factors, load levels, and algorithms for managing spatial change.

In order to achieve this purpose, the following tasks should be completed:

1. to determine the social factors of load on green areas in urban spaces and systematise their impact on the spatial organisation of territories;
2. to develop a model of adaptive transformation of green areas, taking into account different levels of social load;
3. to develop an algorithm for managing spatial transformations of green areas in accordance with social load.

Methods

The research methodology is based on a systemic approach, methods of structural and functional analysis, comparative typology, and elements of graphical visualization. Qualitative analysis was applied to identify the social factors which shape the load on urban space.

The analysis of practical cases on adaptive transformation of urban green areas allows us to combine empirical experience with theoretical principles. The selected examples represent various scenarios of transformation starting from preserving the natural structure with a low level of social load to introducing functional zoning with moderate and intensive spatial adaptation and technological solutions with a high load. The integration of both international and Ukrainian practices makes it possible to identify specific management tools that contribute to the improving of the efficiency of green space usage, create a practical basis for improving urban strategies, and at the same time reduce the risk of excessive conceptualization, ensuring the evidence base and practical value of the research.

Results

In the contemporary context of urban development, landscaping issues occupy one of the central roles within the spatial environment management system. At the same time, their importance is further increasing due to the need to ensure comfortable living conditions for population, which requires not only maintaining territories in proper sanitary condition, but also preserving natural landscapes, recreational areas and infrastructure facilities of public importance Zadorozhnia (2021). In this context, green spaces are regarded as a key element of spatial organisation, that can be adaptively transformed in response to changes in the social load on urban space. Therefore, their rational use and renewal create the conditions for improving the quality of urban environment, satisfying the needs of population and ensuring their rights to a safe, environmentally sustainable and inclusive environment.

We support the ideas mentioned by Sokolan and Kucherenko (2021) that the historical evolution of urban development demonstrates its close connection with social and economic development and the institutional formation of the management system. Whereas earlier the primary tasks were focused on providing engineering infrastructure and rational placement of facilities, at the present stage environmental and social factors are of paramount importance. Urbanization, building density and social load on urban space highlight the need for a comprehensive approach to the transformation of green areas. These areas should therefore be considered as adaptive elements of the urban environment, capable of performing multifunctional tasks – starting from environmental protection to providing space for social integration and communication.

Specifically, Svashenko and Prokopenko (2024) note that the natural framework of cities, the main element of which is green spaces, constitutes a fundamental factor in creating a favourable urban environment. Its significance is considerably heightened under conditions of increasing anthropogenic pressure, as green areas mitigate the effects of negative factors, maintaining ecological

balance, and enhancing residents' comfort and quality of life. In the system of adaptive transformation of urban space, green spaces perform a dual function: ecological (air purification, noise protection, microclimate regulation) and social (creating conditions for rest, recreation and inclusion of various population groups). The effectiveness of their implementation depends on the species diversity, the flexibility of spatial configuration and the capacity to adapt to the dynamics of social pressure on the urban environment.

Modern urbanization processes highlight the critical importance of preserving and enhancing the urban environment, as its quality directly affects the psychophysical state of the population. Green spaces play a leading role in this situation, performing sanitary, hygienic, aesthetic, and recreational functions. They create a comfortable space that contributes to the formation of a healthy urban environment and play an important role in shaping the unique image of a city. At the same time, most cities suffer a deficit of high-quality greening and a lack of a systematic approach to the formation of green areas. Parks, squares and boulevards are often treated as a territory for buildings, and it leads to the degradation and loss of natural elements of urban space Bondarenko (2025).

We consider this tendency to be a key threat to the creation of sustainable cities. Therefore, within the context of the adaptive transformation of green areas the priority task is to protect and reconstruct the existing landscapes, recultivate natural areas, and implement a systematic approach to greening taking into account the social load on urban space.

It should be emphasised that while developing the principles for the spatial transformation of green areas, it is necessary to consider the social factors that determine both the level and nature of the load on urban space. We can state that these factors shape the peculiarities of land usage and the intensity of its exploitation, and need corresponding management decisions (Table 1).

Social factor	Characteristics of impact	Consequences for green areas
Population density	Increase in the number of visitors per unit area	Overloading of infrastructure, densification of territory
Recreational needs of population	Diversity of leisure activities (sports, cultural, recreational events)	Need for zoning and functional diversification
Transport accessibility	Intensity of visits due to convenient connection	Increased anthropogenic pressure
Socio-demographic structure	Presence of children, elderly people, young people	Demand for inclusive and multifunctional infrastructure
Social practices and events	Mass events, cultural events	Seasonal peak loads, risk of degradation of green spaces

Table 1

Social load factors and their impact on urban green areas

Source: compiled based on Sokolan and Kucherenko (2021); Bondarenko (2025); Elbakidze et al., (2023); Jang et al. (2020); Kiseliov and Kiseliova (2021).

According to the data presented in Table 1, the main determinants of social load are population density, transport accessibility, socio-demographic structure, recreational needs and land use practices.

The dominance of built environment is also an urgent issue for modern cities, as it reduces both the qualitative and quantitative characteristics of urban greening. In their studies, Bondarenko (2025); Zibtseva and Yukhnovskyi (2019) note that landscape objects, such as parks, gardens, squares, and boulevards, often lose their functional mission, turning themselves into territorial reserves for building and infrastructure projects which is especially relevant for post-Soviet cities of Ukraine and leads to the gradual degradation and disappearance of green zones. As a result, in conditions of increasing social load on urban space, it is particularly hazardous, as the reduction

of green areas negatively influences ecological balance and reduces the overall level of comfort of urban life. In countries with post-socialist history, there is a tendency to expand the number of urban green spaces. However, sustainability can only be achieved by combining green infrastructures development with nature-oriented solutions, grounded on the development of urban planning documentation at the national, regional, and local levels. In most countries, the planning system promotes the formation of natural environment and the minimization of territorial expansion. At the same time, one of the key challenges of modern urban planning is the accessibility to urban green areas and ecosystem services provided by green spaces. Despite the existence of various methodological approaches to determining this indicator, no consensus has yet been reached regarding their application in compact cities. This aspect remains insufficiently considered in most planning strategies for the development of Ukrainian cities.

Green space has a multifunctional purpose: it performs recreational, ecological, aesthetic and cultural functions, as well as contributes to the preservation of biodiversity. That is why the transformation of green areas should be implemented adaptively, taking into account the needs of population, their social significance and their multifunctionality within the urban environment. Such scientists as Shyshchenko et al. (2021) note that, the «greenness» of the urban environment is assessed comprehensively in developed countries, i. e. not only by the presence of green areas, but also by the level of integration of green technologies into energy and transport infrastructure, air quality, waste disposal efficiency, etc. Bondarenko (2021).

The study of literary sources demonstrated that the restoration of Ukrainian independence fundamentally changed the priorities of spatial development and created the foundation for a national urban planning strategy. Therefore, the most effective approach to managing spatial development management is a hierarchical model, which involves the preparation of urban planning documentation at the national, regional and local levels. The standardization of green areas makes it possible to solve the problems of urban environment effectively. In current conditions, the most urgent need is to improve planning methodology, particularly in the context of decentralization of investment, changes in land use and the necessity to strengthen the environmental component in urban development in Ukraine. The basis for sustainable urban development is multifunctional green space, which competes with other types of land use and is often displaced by residential construction. In practice, the principle of urban densification which is considered to be an element of sustainable growth leads to the reduction of green areas. As a result, there are few green spaces in small cities in Western Europe Zibtseva (2018).

It is important to emphasise that different levels of social load predetermine corresponding spatial transformation of green areas. The level of social load on green zones depends on a number of factors, such as: their functional purpose (different types of green zones have different social loads: public green zones (park, squares) are intended for the general public, while specialised ones are intended for specific groups, for instance, green zones at hospitals or schools), area standards according to the legislation, the building density around green zones (the higher the density, the greater the social load, as the number of people who can use it increases, which can lead to overuse, pollution, and destruction of green spaces) and the intensity of use. With high recreational activity (a large concentration of people), the load on the area increases, which may require additional maintenance and protection measures). Another important factor to consider is demographics: different age and social groups have different needs and place a varying load on green zones; young people are looking for active recreation and various cultural events, couples with children need playgrounds and family areas to relax with friends, and older people need mostly accessible infrastructure and quiet areas.

To better understand the logic of change, a model of adaptive transformation has been developed. It reflects the relationship between the degree of load, the principles of spatial organisation and the result of green infrastructure development (Fig. 1).

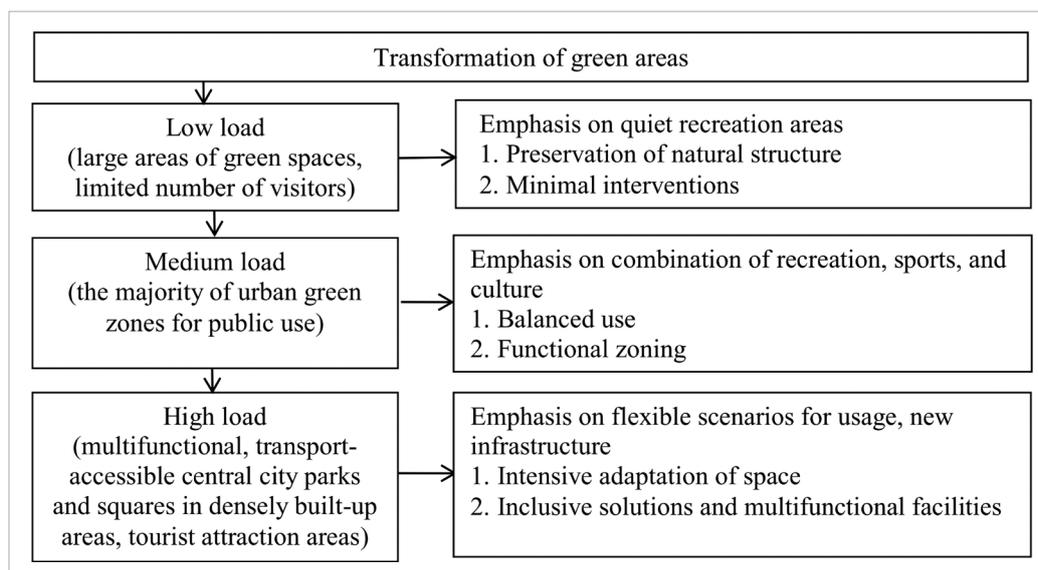


Fig. 1

Adaptive transformation of green areas in accordance with the level of social load

Source: compiled based on Svashenko and Prokopenko (2024); Hansen et al. (2019); Orlovska and Pavlenko (2024)

The analysis of data presented in Fig. 1 revealed that the adaptive transformation of green areas follows three main scenarios. The key issue is to preserve the natural structure under low load, balanced use and zoning under medium load, and intensive spatial and functional adaptation under high load. The study confirmed that the degree of load directly correlates with the scale and nature of changes in the spatial organisation of green areas, which makes it possible to propose a flexible management mechanism where transformation occurs gradually, in accordance with the current level of anthropogenic impact.

In today's world, cities are centres of socio-economic development, but their rapid urbanization and growth of anthropogenic impact provoke significant ecological challenges. It should be noted that the most common problems are air and water pollution, the disappearance of green areas, the degradation of biodiversity, and the intensification of the urban heat island effect. That is why, in the context of climate change, the growth of population density and active construction, the issue of creating a green urban ecosystem is becoming increasingly relevant. Moreover, the insufficient integration of environmental principles into the urban planning process worsens the quality of people's life and makes cities more vulnerable to the negative effects of globalization. According to Orlovska and Pavlenko (2024), natural areas and green infrastructure elements are mostly affected by pollution. A promising way to address these challenges is to create and develop a balanced green urban ecosystem, as it positively influences the quality of life and create stable urban systems. Green urbanism involves interdisciplinary cooperation between architects, urban planners, ecologists, transport engineers, sociologists, economists and other specialists to ensure the minimisation of energy, water and material use throughout the entire life cycle of a city.

In the context of our study, it is essential to emphasise that systematic monitoring of green spaces is a key precondition for the adaptive transformation of urban green areas. The increase of the number of trees in the cities does not only create a comfortable microclimate by lowering temperatures and air purification, but also serves as an indicator of the urban space's ability to cope with the growing social load. Street plantings, which are most vulnerable during the reconstruction of urban streets, require regular monitoring and proper maintenance. According to the Ukrainian legislation, the green area monitoring system performs the function of collecting, analysing and forecasting changes in the condition of green spaces; as a result, some grounded management decisions are made Bakova and Karpinskyi (2022).

The management of green areas in cities is a part of an adaptive urban development strategy,

where green spaces are considered to be not only a decorative or ecological resource, but also a regulatory mechanism balancing social pressure and spatial development. They perform a wide range of functions, starting from forming green corridors and buffer zones to creating recreational environments that ensure the city's adaptation to climate change and growing urbanization pressure. Street trees are of particular importance in this system, as their characteristics determine the quality of the ecosystem services provided. Regular inventory and accounting of green spaces create the conditions for the formation of a flexible model of green infrastructure management that integrates ecological, social, and technical considerations Zhuk and Myshiliuk (2025).

Such researchers as Kiseliiov and Kiseliiova (2021) emphasise that urban space is formed by a combination of buildings and open areas, among which green zones and public spaces function as 'buffers' of social pressure. In the context of limited opportunities for creating new cities, the reconstruction of existing territories becomes particularly important, and the adaptive transformation of green areas is a tool for improving the quality of urban environment. That is why the creation of such spaces in accordance with the concept of sustainable development makes it possible to increase their sustainability, create additional opportunities for recreation and social interaction, and balance the spatial distribution of social pressure.

The analysis of practical cases on adaptive transformation of urban green areas allows us to combine empirical experience with theoretical principles. The selected examples represent various scenarios of transformation starting from preserving the natural structure with a low level of social load to introducing functional zoning with moderate and intensive spatial adaptation and technological solutions with a high load (Table 2).

Table 2

International and domestic experience of adaptive transformation of green areas in urban space

Source: compiled on the basis of reviewed literature

Case	Location	Characteristics	Practical application for adaptive transformation
Park am Gleisdreieck (Park am Gleisdreieck, 2025), Fig. 2. a	Berlin, Germany	Transformation of former railway tracks into a large multifunctional city park (area: ~30 hectares). Combination of areas for sports, children's and cultural events, elements of wildlife and community participation in space management	The reconversion of industrial areas makes it possible to rapidly increase the area of green spaces and distribute the social load through clear functional zoning and public participation tools.
Gardens by the Bay (Garden of wonder, 2025)	Singapore	An urban botanical complex with technological solutions (climate-controlled greenhouses: Cloud Forest/Flower Dome, Supertrees), high visitor traffic and perfect infrastructure for tourists and locals	Under conditions of high load, it is effective to combine infrastructure intensification (vertical and climate-controlled solutions) with the creation of clearly delineated paid and free zones for the controlled distribution of visitors
Finger Plan / Green wedges (Danish Ministry of the Environment, 2015)	Copenhagen, Denmark	The regional plan (Finger Plan, 1947 – evolution) concerns the development of urbanisation 'fingers' with interfunctional green wedges that preserve recreational and agricultural spaces alongside building density.	The integration of green wedges at the regional level creates reserves for future adaptation, ensures a balance between development and recreational spaces, and makes it possible to regulate loads through transport and spatial planning

Vistula (Vistulan) Boulevards / Bulwary Wiślane (Startuje budowa bulwarów), Fig. 2.b	Warsaw, Poland	Reconstruction of the waterfront with an emphasis on public space, improvement of accessibility and multiple functions (walks, cultural events, seasonal structures). Integrated design with transport and tourist infrastructure	Coastal projects are an effective tool for disburdening central parks, as even relatively simple architectural and functional solutions (piers, stairs, seating areas) change the scenarios of using the space.
Natalka Park (Natalka Park, 2021), Fig. 2.c	Kyiv, Ukraine	A new park along the Dnipro River (≈ 25 ha), modern infrastructure, children's and sports areas, bike paths: an example of large-scale urban investment in coastal space	This domestic example of a large-scale riverside park confirms the importance of monitoring visitation and the need for differentiated maintenance of areas to ensure their sustainability
Snopkivskyi Park (Snopivskyi Park, 2025)	Lviv, Ukraine	A historical city park (≈ 48 ha), a complex of green spaces, cultural objects and recreational areas; a status of a local landmark of park art.	For medium social load, measures for functional zoning and preservation of the tree fund are appropriate, as well as taking into account the cultural and historical component in the transformation process.
Dnipro Embankment (Interesting things about Dnipro, 2025)	Dnipro, Ukraine	Large coastal system (embankment, reconstruction and improvement of public services, combination of recreational and urban functions)	Large-scale coastal infrastructures function as social and recreational resources for large cities, but they require systematic operational support and regular monitoring of the infrastructure and usage practices.

The analysis of data presented in Table 2 demonstrates that international and Ukrainian case studies provide insight into the characteristics of adaptive transformation of green areas in response to social pressure. For instance, examples from Germany (Park am Gleisdreieck in Berlin) Park am Gleisdreieck (2025) and Ukraine (Snopkivskyi Park in Lviv) Snopivskyi Park (2025) confirm the effectiveness of scenarios connected with preservation and moderate intervention under low and medium pressure. In both cases, zoning measures, tree conservation and active community involvement play a key role in ensuring the sustainability of management decisions and minimizing the risks of land degradation. Meanwhile, the experience of Singapore (Gardens by the Bay) Garden of wonder (2025) shows that under conditions of high load, it is possible to apply infrastructure intensification and technological solutions such as vertical greening, climate-controlled pavilions and controlled visitor routes, which help to withstand significant population pressure without losing ecosystem services. Therefore, although this approach requires significant financial resources, it is a rather promising way to be applied in tourist-attractive areas of large cities in Ukraine.

One more example is Finger Plan in Copenhagen, Denmark Danish Ministry of the Environment (2015). It illustrates the principle of regional planning through the creation of green wedges between urban development zones. This experience demonstrates the need to take into account the territorial scale of transformations: from local parks and squares to inter-municipal recreational spaces. Therefore, the integration of regional solutions makes it possible to create reserves for further adaptation, balance the load between central and peripheral areas, and increase the efficiency of transport accessibility. Similarly, the example of Bulwary Wiślane in Warsaw Startuje

budowa bulwarów (2016) demonstrates the importance of high-quality reconstruction of coastal spaces, as it simultaneously reduces the load on central parks and creates new public locations for cultural and social practices. Similar trends can be observed in Ukraine. For example, Nataalka Park in Kyiv Nataalka Park (2021) and the embankment in Dnipro Interesting things about Dnipro (2025) are striking examples of large-scale urban transformation that improves the accessibility of recreational spaces but at the same time requires constant operational support and regular monitoring.

Discussion

Contemporary architectural and urban design should take into account the energy efficiency of buildings, rational use of resources, and environmental responsibility across all stages of the urban life cycle, starting from construction and up to disposal. In our opinion, greening has become one of the key directions of sustainable urban development programmes, and the adaptive planning of urban green spaces is recognised as a basic condition for improving the ecological environment.

The most critical factors are population density and recreational needs, which determine both the intensity of visits and the need to diversify the functions of green areas. This provides a basis to argue that the principles for transforming green spaces should be based on an adaptive integration of spatial and socially oriented solutions. We believe that the combination of population density and recreational practices creates the most significant pressure on green areas.

A comprehensive analysis of case studies shows that it is very important for Ukraine to combine the preservation and reconstruction of existing green areas and gradual introduction of technological solutions in areas of high social pressure. The experience of the Netherlands and Poland confirms the importance of strategic regional planning and coastal reconstruction as tools for reducing pressure on central city parks. Accordingly, the adaptive transformation of green areas should be concerned not only as a process of landscaping, but as a multi-level management system including planning, operation and monitoring, integrating local solutions into the broader context of sustainable urban development. In our opinion, it shows the necessity to develop complex approaches to the transformation of green areas in Ukraine. We believe they will ensure their multifunctionality and compliance with modern social and environmental challenges. Urbanisation should be considered as a concept aimed at regulating the development of urban territorial systems, where sustainable development is a key goal.

We consider it to be necessary to illustrate visually the practical outcomes of adaptive transformation of green areas in different countries around the world in the form of photographs. This allows us to show how specific architectural and planning solutions and urban programmes change the appearance of urban space in accordance with social demands. The examples of transformations presented in Fig. 2 demonstrate the effectiveness of integrating the principles of sustainable development, inclusiveness and adaptive management.

At the same time, OECD Regions and Cities at a Glance data show that in most agglomerations of OECD member countries, a significant part of population has an access to a green urban area of at least 1 hectare within a 15-minute walk, which emphasizes international accessibility standards OECD (2018).

However, it is important to note that physical proximity does not always guarantee real accessibility for all categories of population. For people with low mobility (people with disabilities, old-aged people, parents with prams) barrier-free infrastructure is a key factor. This requires the presence of ramps, low curb, specially equipped benches, safe pedestrian crossings and accessible public toilets. Thus, measuring the accessibility of green areas only in terms of distance or time must be supplemented by qualitative parameters of inclusiveness that reflect the real possibilities for



Fig. 2

Examples of adaptive transformation of green areas according to social load

Source: compiled on the basis of reviewed literature

all social groups to use space. It should be noted that the concept of the '15-minute city' in international practice only acquires its full meaning when it combines spatial proximity with the principles of a barrier-free environment.

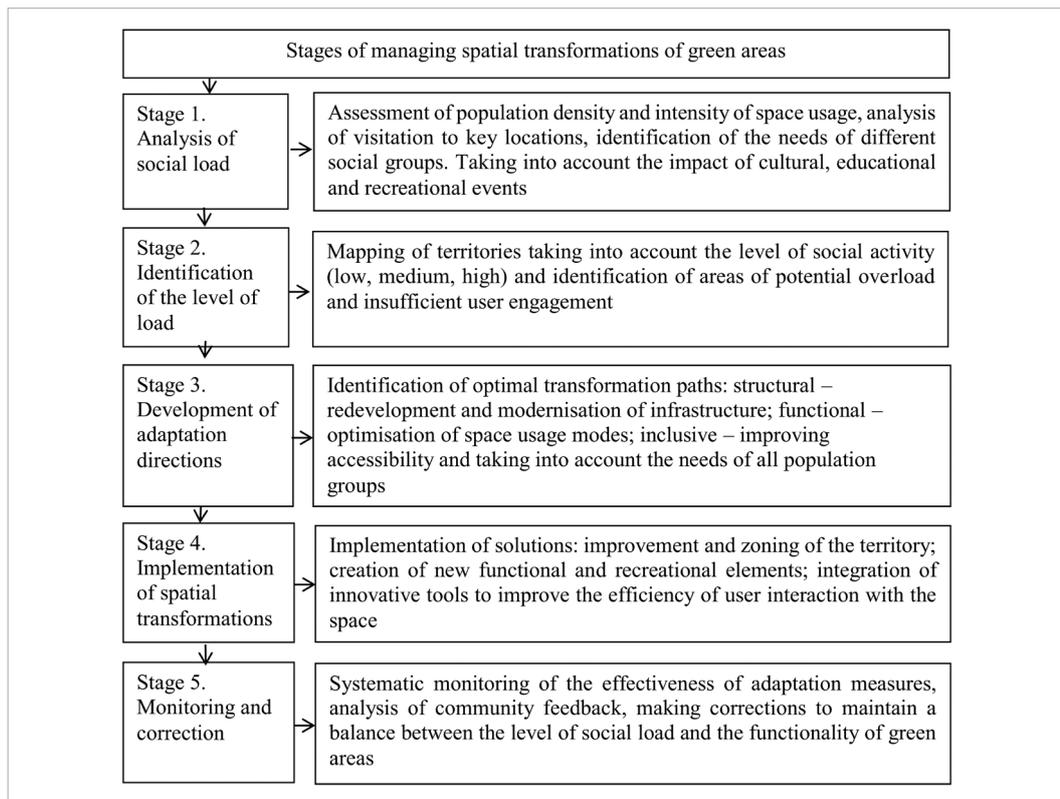
Therefore, in order to implement the principles of spatial transformation of green areas effectively, it is necessary to use an algorithmic approach that combines analysis, planning, implementation and monitoring of all the processes. In our opinion, this approach ensures consistency in management decisions and creates conditions for flexible response to changes in social load (Fig. 3). As a result, the conceptual approach to managing spatial transformations presented in Fig. 3 covers five interrelated stages: analysis of social load; identification of its level; determination of adaptation directions; implementation of transformational decisions; and monitoring of effectiveness.

The analysis of the suggested algorithm showed that it is the cyclical nature that ensures the stability and adaptability of processes. In other words, the results of monitoring become the basis for re-analysis and correction of management decisions.

Fig. 3

Management of spatial transformations of green areas taking into account social load

Source: based on Zadorozhnia (2021); Bakova and Karpinskyi (2022); Zhuk and Myshiliuk (2025)



Conclusions

The study confirmed that social load is one of the determining factor in the spatial transformation of green areas in urban spaces. It was found out that its key factors are population density, transport accessibility, recreational needs and socio-demographic structure, since they shape the directions of land usage and determine the need for differentiated management decisions.

The developed model of adaptive transformation demonstrated the relationship between the level of social load and the scale of spatial changes (from preserving the natural structure at low load to intensive infrastructural and functional adaptation under high load). The proposed algorithm for managing spatial transformations ensures the consistency and cyclical nature of the adaptation process, including analysis, planning, implementation, and monitoring.

Therefore, the research findings are of theoretical and practical significance, as they can serve as a foundation for the development of municipal management strategies, improvement programmes and inclusive urban space practices. Further research should be focused on the quantitative assessment of social load, the integration of such indicators into geoinformational systems, and the development of practical recommendations for local authorities.

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