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PUBLIC GREEN SPACES AS A COMPONENT OF URBAN ENVIRONMENTAL CONTINUITY – ACCESSIBILITY ANALYSIS IN RZESZÓW

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Abstract
In light of ongoing climate change and the growing prevalence of lifestyle-related diseases, access to attractive green spaces is becoming increasingly important and should be treated as a priority in urban development. The benefits associated with proximity to green areas are extensive, significantly influencing both physical and mental health. However, popular urban green space rankings published in the press do not adequately reflect the actual accessibility of public green spaces. Many of the advantages identified are available only to a limited group of users, while some remain entirely inaccessible. Proximity to urban greenery is particularly crucial in densely populated residential districts dominated by multi-family housing, in contrast to areas of single-family housing typically surrounded by greenery and private gardens. Thus, the type and density of residential development directly shape the demand for high-quality public green spaces. Ensuring attractive green spaces in the historic city center may also help preserve its urban fabric by mitigating the risk of depopulation. Urban planning processes aimed at managing city morphology should take these differences into account. The present study analyzes the current state and actual accessibility of public green spaces for residents of Rzeszów. The results provide a basis for identifying potential future changes in the distribution and availability of urban green areas across the city's districts.
Keywords*: Urban green spaces, Accessibility analysis; Urban fabric preservation, Rzeszów*

Introduction

Cities are the living environment for a growing portion of the population. Currently, over 70% of all Europeans and over 60% of Poles live in urban areas. Green spaces play a special role in the structure of cities. They increase the attractiveness of residence, improve residents' quality of life, and mitigate the negative aspects of urban life. They also sustain the biodiversity of the natural environment. Therefore, shaping them should be a priority for local governments and occupy a special place in urban development policies [1]. Many Polish urban centers are taking on this challenging task, recognizing these advantages. The green structure of every city consists of various types of greenery, including parks, squares and green areas, allotment gardens, street greenery, river boulevards, and urban forests. Each type, depending on

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its size, development method, and infrastructure, plays a slightly different role and provides different ecosystem services in the city. Proper landscaping of publicly accessible green spaces, their saturation with numerous recreational and leisure infrastructure elements, and a high tree density contribute to the perception of these spaces as attractive. However, whether a city can truly be called "green" is determined not only by the number of square meters of green space per capita, the percentage of green spaces in the city's total area, or the number of parks – especially large ones. Accessibility for the widest possible range of residents becomes crucial. In cities with historic old towns that are struggling with depopulation of city centers, maintaining a healthy living environment for residents should be a priority.

Availability of urban green areas

The concept of accessibility in relation to green spaces as part of the urban structure can be considered from many perspectives. The basic criterion seems to be the distance from home or work to reach them. Various means of transport can also be considered, with the quality of connections and travel time being important. Equally relevant is whether existing connections to the destination are adapted to users with different individual needs. However, assuming that reaching green spaces should require minimal effort and energy expenditure, this public space should be accessible within a short, pleasant, and safe walk from home [2].

A number of studies have been conducted, the conclusions of which demonstrate that simply looking out of a window at a wooded area results in a measurable improvement in well-being. In this context, it can be added that even a view from an apartment or workplace directly onto tall vegetation is an important form of access to urban green space [3]. This means that planning intensive residential development in the immediate vicinity of city parks and squares is even more justified. It should be noted that, in assessing the visual benefits of trees, one must determine the maximum distance at which they are perceived as distinct organisms rather than as a uniform patch of color. This phenomenon occurs both at a significant horizontal distance and when observing trees from a great height.

The actual availability of green spaces varies from city to city. This is due to numerous factors, influenced by individual circumstances, such as the natural, historical, and social context. The causes of this situation can be traced back to the past, for example, to the uncontrolled development of the urban fabric of a given settlement unit, and to the current lack of vision, tools, or appropriate resources for creating urban green spaces [4]. With the upcoming amendment to the Spatial Planning Act, in Polish cities, pending the adoption of general plans, only local spatial development plans provide real protection from development in green spaces not owned by the municipality.

The growing public awareness, intensified by the experience of pandemic lockdowns , means that city residents, and consequently also local governments, feel the need to increase the number and availability of green spaces in cities. However, it seems that these actions are still insufficient [5]. In many cases, this is due to the shortage of space available for this purpose. Another reason may be the high prices of land in cities, for which public funds are not available [6]. Therefore, good examples of the creation of large-scale urban parks are difficult to find [7]. Currently, developing green infrastructure often involves the creation of small, so-called "pocket" parks, squares, and thematic gardens, e.g., sensory gardens, near educational institutions. Ongoing research and initiatives aim to enhance the integration of nature into school environments [8]. Revitalization of existing recreational green areas, the development of urban meadows, and the planting of new trees and low plants on green areas and along traffic routes are also taking place. Initiatives to implement green roofs and vertical greenery on public buildings are also noteworthy [9]. This tendency to restore the presence of nature in urban environments aligns with a wider movement promoting traditional, low-impact construction methods and the increased use of sustainable, natural materials in architecture [10].

Functions of urban green areas

Urban greenery is assigned a wide variety of functions. It can play a beneficial role in shaping social relations, educating society, or supporting the economy, among other things. One of its most important functions is mitigating unfavorable environmental conditions. This role primarily involves reducing air pollution (absorbing carbon dioxide and retaining harmful dust [11]), promoting water retention, reducing noise levels, providing protection from wind and erosion, and lowering air temperature [12]. Another important function is enabling passive and active recreation for city residents. Properly designed and maintained urban greenery enables recreation for a diverse population of all ages and physical abilities. This can involve walking along paths and sidewalks, resting on benches or in gazebos, practicing sports in designated fields and gyms, and recreation in playgrounds or at tables with game boards [13]. The recreational potential of green spaces is largely influenced by whether these facilities are surrounded by diverse vegetation. Its quality influences the perception of a given space as interesting throughout the seasons. Another function of green spaces is aesthetics. Well-designed greenery complements urban spaces, positively influencing their character and image. It can enhance appearance, highlight certain objects, or conceal architectural imperfections [14].

Health benefits of access to green areas

All the advantages and functions of green spaces described above are closely related to their other role – health promoting. The list of benefits enjoyed by residents with access to green spaces is very extensive and includes many items that have a strong impact on both physical and mental health [15]. Contact with nature during recreation positively affects the health of the nervous system. Various types of physical activity in natural surroundings have a positive effect on the circulatory system and musculo-skeletal system. Lowering temperature and regulating air humidity, influenced by vegetation, creates a specific microclimate that has a beneficial effect on people. Because greenery improves air quality, people staying near it have healthier respiratory systems. The body is better oxygenated, which allows it to function more efficiently. The mere presence of people surrounded by trees significantly affects their mental well-being. Greenery alleviates the effects of stress and lowers blood pressure [16]. The presented list includes only the basic benefits enjoyed by residents with access to green spaces. In light of ongoing climate change and the epidemic of lifestyle diseases, access to attractive green spaces is becoming increasingly important and should be a priority direction in urban development.

Urban greening rankings influencing public opinion

From time to time, various rankings of urban green areas reach the public. Published in the press, online, and on social media, they provoke discussions about the condition of individual cities. They are often widely commented on by the local press and mobilize local governments to respond. Such a heated debate was observed in May 2019, when the website domiporta.pl published an article presenting an analysis based on Central Statistical Office (GUS) data from 2018 [17]. Rzeszów ranked last among the analyzed cities. The ranking determined the share of green areas in the city's area at 8%. Cited by city newspapers and online portals, it caused a media stir in Rzeszów. The city's then-mayor, Tadeusz Ferenc, accused the GUS data of being unreliable. It is worth noting that the GUS does not perform area calculations. In accordance with its statutory activities, it compiles and publishes information mandatorily submitted by local government units. Rzeszów officials pointed out that the analysis took into account municipal forest areas. Compared to other cities, there are very few

such areas within Rzeszów's administrative boundaries. Furthermore, the publication also cited the interesting Husqvarna Global Report from 2012.

The share of respondents who were willing to pay a higher price for an apartment near green spaces and answered "probably yes" and "definitely yes" was 74% [18]. Therefore, the weakest result in the ranking, for obvious reasons, apart from the city authorities, could also have seriously alarmed investors whom the city hall was trying to attract. With hindsight, we can observe the clear impact of the public discussion in 2019. A new publication of data from the Central Statistical Office revealed a huge jump in the percentage share of parks, green areas, and residential greenery in Rzeszów. The increase was from 2.9% in 2018 to 13.4% in 2019. The number of reported green areas increased from 100 to 748, and their total area increased almost five-fold [19]. A summary of the aforementioned data is presented in Table 1.

Table 1. Green areas in Rzeszów according to the Central Statistical Office data for 2018 and 2019

Rzeszów		2018	2019
Area	km^2	**120,4**	**126,61**
Population	people	**191 564**	**196 208**
Population density	people/km^2	**1591**	**1550**
Parks for walking and recreation	nbr.	**15**	**15**
Parks for walking and recreation	ha	**83,27**	**83,27**
Green squares	nbr.	**100**	**748**
Green squares	ha	**77,44**	**1382,07**
Street greenery	ha	**232,33**	**237,22**
Residential green areas	ha	**192,09**	**232,59**
Parks, green squares, and residential green areas	ha	**352,8**	**1697,93**
Cemeteries	nbr.	**15**	**16**
Cemeteries	ha	**54,64**	**54,64**
Municipal forests	ha	**9**	**9**
Share of parks, green squares, and residential green areas in total area	%	**2,9**	**13,4**
Share of all green areas in total area	%	**5,39**	**15,79**

Given the observed enormous leap, one must ask whether the city's surface area was truly enriched with new green spaces in just one year? Such a change, such as designing, approving, and constructing an additional 648 urban green spaces, would have to be implemented on a very large scale in a very short time. It would have consumed significant resources and required the involvement of a huge number of workers – from designers, officials, and contractors. A simple calculation shows that an average of 1.78 urban green spaces/squares would have to be created every day. Such changes in Rzeszów's urban space were certainly not observed in 2019. In turn, 2020, the year when the new data was published, brought so many challenges related to the ongoing Covid-19 pandemic that it's not surprising that the activities of influential media and local governments focused on other areas. Therefore, the question remains: what is the actual research usefulness of the Central Statistical Office data in the field of greening Polish cities? It seems that the drastic changes in the percentage of green spaces in Rzeszów are evidence of a change in the method of preparing statistical data for the GUS by Rzeszów officials in 2019. It can also be assumed that their approach was strongly motivated by the stance of the politicians in power in the city. Therefore, comparing the green areas of Polish cities based on GUS data does not seem to provide a strong basis for creating reliable rankings.

Given this, it is worth taking a closer look at the data sets prepared based on a common method applied to all the studied areas, prepared by a single team of authors. In March 2021, another ranking reached the public, sparking renewed discussion. The website observatory.miasta.pl presented an article titled " Which city has the most green areas? The answer from a satellite perspective" [20]. It cited a scientific publication describing extensive research conducted by Wojciech Łachowski and Aleksandra Łęczek – Green areas in large Polish cities. Analysis using Sentinel 2. The researchers used the method of analyzing satellite images from the Sentinel 2 mission from the summers of 2018 and 2019. It is worth noting that this is the same period described in the context of the cited ranking based on research from the Central Statistical Office. The study covered 38 Polish cities with a population exceeding 100,000. This time, in addition to the share of green areas in the total city area, greenery fragmentation was also measured using an analysis of the edge-to-center ratio of green areas, and greenery accessibility was measured by determining the percentage of people with access to green areas within a 5-minute walk of the total population. Rzeszów ranked 27th out of 38 cities in terms of the percentage of high-quality green areas in the total area. Meanwhile, the accessibility analysis placed it first, with a 77.9% share of the total population. As might be expected, this ranking was often cited with great pride and satisfaction by politicians in charge of local governments in the city. While this is entirely understandable, to obtain a complete picture and assess the actual usefulness of the ranking by the observatory.miasta.pl website, it is necessary to refer to the original article published in Urban Development Issues [21]. The authors measured the condition of vegetation and designated areas of "high-quality greenery" in the analyzed cities. The areas selected in this way included city parks and squares, green areas between multi-family residential buildings, and home gardens. According to the adopted method, forests, dense shrubbery, and lush meadows were also considered as green areas. However, cultivated fields and areas with exposed soil were not taken into account. It should be noted that the areas were not differentiated based on land ownership. This means that land belonging to the Municipality of Rzeszów and privately owned land were analyzed equally. The authors observed and described a significant discrepancy between the obtained results and data from the Central Statistical Office. The average share of green areas in cities, according to the study, was twice as high as in the official statistics. For some cities, this discrepancy reached almost 400%. According to the Central Statistical Office, the total share of green areas in the area of Rzeszów was 16.42% (the sum of forests and landscaped green areas). The percentage of high-quality greenery obtained in the described study reached a staggering 46.8%. Due to the negligible size of municipal forest areas, Rzeszów nevertheless lagged behind the leaders (27th place out of 38 analyzed cities) and ranked below the average of 52%. The researchers obtained very interesting results when analyzing the temporal accessibility of green spaces exceeding 1 hectare. The method employed by the authors was based on a network model of pedestrian access. This model comprised shared roads, sidewalks, paths, and stairs. A 5-minute walking distance of 500 meters was assumed. This method was used to define zones whose population numbers were summed. For this purpose, the PESEL population database, which includes persons registered for permanent residence at specific addresses, was used. As already mentioned, Rzeszów this time ranked first out of 38 cities in the category of 5-minute access to "high-quality green spaces" with a score of 77.9%. The average percentage of people with access to green spaces within a 5-minute walk for all the cities analyzed was 50%. Both the advanced communication model and the extensive address database used in the study seem to be very precise indicators. At the same time, the very concept of accessibility in the context of "high-quality green spaces" requires consideration. Given the mentioned lack of ownership

diversity and the inclusion of unmanaged green spaces such as lush meadows, its actual accessibility for all residents has not been fully verified. Large private plots, allotment gardens, and other wooded and bushy areas inaccessible to residents due to their unmanaged nature were certainly included among the five-minute accessible green spaces. If such areas are located near large and densely populated residential areas, they could significantly influence the study results, distorting the actual accessibility of green spaces. It should be noted that many of the areas considered are accessible only to a very limited number of users. It is likely that some are completely inaccessible.

It follows that the function of the analyzed green area is very important, because depending on it, it is possible to determine the level of accessibility of the area and estimate what needs of residents it meets.

In the context of the discussed rankings, it is worth mentioning that in 2021, another ranking was published, this time prepared by the rynekpierwotny.pl website. It included an analysis based on Central Statistical Office data from 2019. Rzeszów, with approximately 16% share of green areas in the total area, again achieved a low position. After excluding municipal forest areas from the study, it achieved second place in the country thanks to its 13% share of green areas in the city area [22].

Types of green areas in the city

It can be safely assumed that every type of urban green space supports mitigating the negative effects of climate change and provides eco-system services to the city and its residents. For this reason, broadly understood care for urban greenery is extremely valuable. At the same time, it is important to recognize that different types and functions of green spaces can provide varying numbers and values of services. They also serve different numbers of users. In this context, it is worth analyzing the basic groups of green spaces, divided according to their functionality. The following should be highlighted:

1. Publicly accessible (open) green areas such as city parks, green areas (squares), street greenery, greenery accompanying public transport, promenades, boulevards, municipal and suburban forests, as well as insulating greenery and windbreaks.
2. Areas with limited (controlled) access such as botanical gardens, zoos, ethnographic gardens, allotment gardens, cemeteries, parks and historic gardens.
3. Accompanying green areas such as estate greenery, front gardens, gardens behind houses, playgrounds, greenery near educational institutions, greenery near service facilities [23].

The absolute priority in planning and policy development of urban green spaces should be areas that can be used by the greatest possible number of citizens, thus ensuring the highest possible accessibility in all its forms. Only areas from the first group mentioned above possess such characteristics. Once a priority group has been identified, it is necessary to consider which publicly accessible green spaces are capable of delivering all of the health benefits listed F noise and pollution is Particularly important. These assumptions require the introduction of a minimum area criterion, which in the case of Rzeszów can be defined as 2 hectares. This limited group includes all 15 city parks, including riverside boulevards. Forest areas should also be considered, however, as unmanaged greenery with limited access for certain social groups, such as people with limited mobility, they should be treated as a separate category of green spaces. Figure 1 presents the development structure of Rzeszów, with fifteen urban green spaces larger than 2 hectares, as well as forest areas located within or adjacent to the city limits.

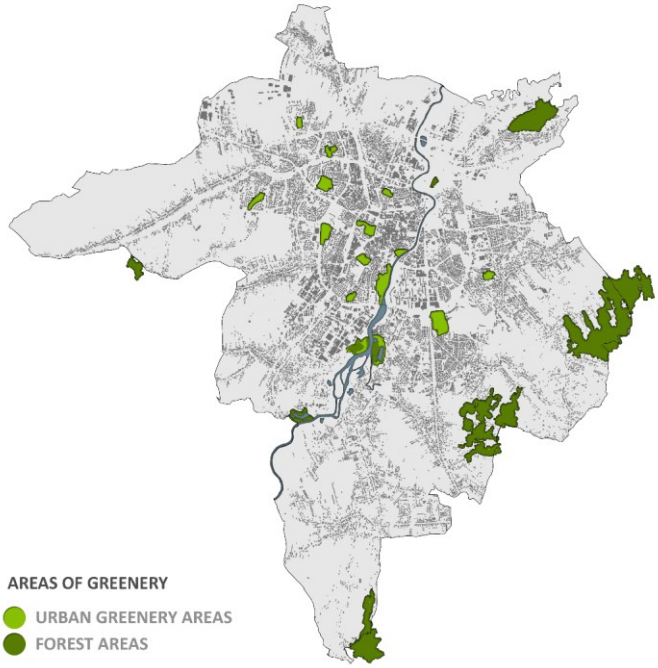

Fig. 1. Location of green areas with an area exceeding 2 ha in Rzeszów

Spatial and demographic structure of Rzeszów

Rzeszów, within its current borders, covers 128.5 km² and has a population of 196,636. These values, and the resulting population density, are very similar to Polish cities such as Toruń and Kielce. Currently, Rzeszów is divided into 33 districts of very diverse character. Due to the incorporation of neighboring rural municipalities in recent years, differences in their development structure and land cover are significant. We see equally significant variation in the population of Rzeszów's districts. When considering access to public green spaces, the most important parameter is population density analysis, i.e., the ratio of the number of residents to the area of the district. For densely populated housing estates consisting of multi-family buildings, proximity to green spaces is most crucial. Their residents lack access to private green spaces, and there are correspondingly more of them per unit area. For residents of districts dominated by single-family housing surrounded by greenery and private gardens, access to city parks is also important, although its priority may be lower due to the fact that gardens partially satisfy the need for contact with greenery. The type and density of residential development therefore directly impacts the need for access to high-quality green spaces. The map of Rzeszów clearly shows the areas surrounding the historic city center with the highest population density. In contrast, the outer estates are characterized by low and very low population density. It can be assumed that population density is directly proportional to the intensity of development and inversely proportional to the availability of private gardens. Analysis of this data is particularly helpful in determining how effectively the city provides its residents with access to public green spaces.

The presented population density map (Fig. 2) is reflected in the Study of Conditions and Directions of Spatial Development (SUiKZP) of Rzeszów [24] (Fig. 3).

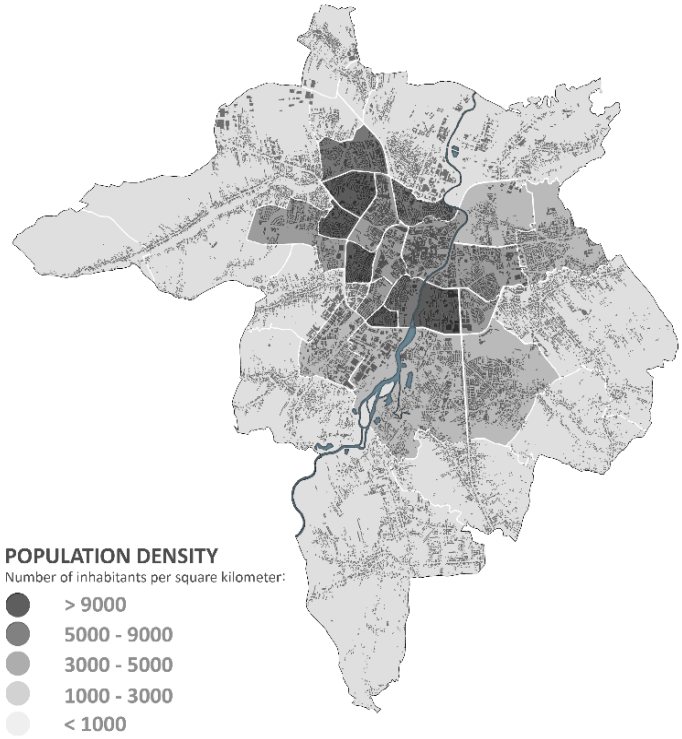

Fig. 2. Population density map of Rzeszów districts

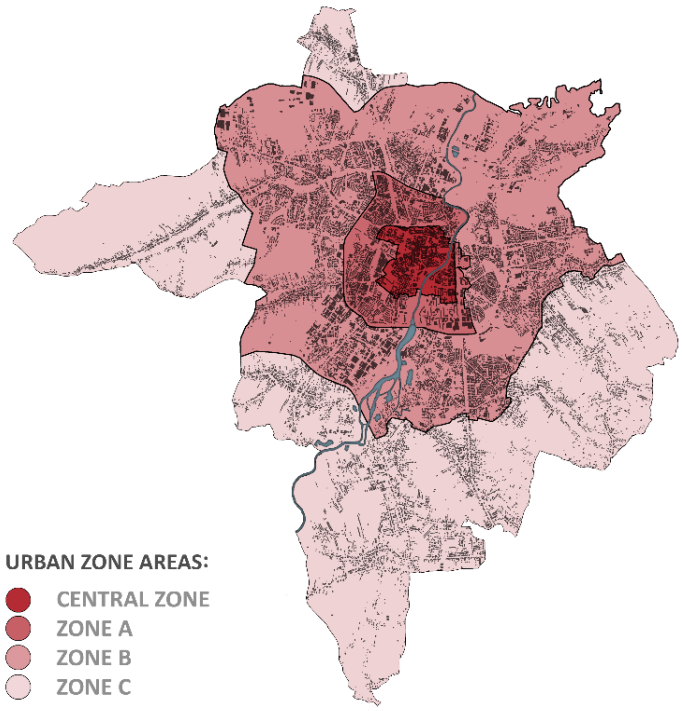

Fig. 3. Urban zones designated in the SUiKZP of Rzeszów

The designated urban zones A, B, and C are located concentrically in relation to the city center and reflect the stages of its spatial development and the transportation system, which constitutes the framework of the city's development. Zone A, including the downtown area, is inhabited by approximately 32% of the city's population, with a population density exceeding 6,000 people/km², and the dominant residential development being multi-family housing. Zone B is inhabited by approximately 53% of the city's population, with a population density of less than 2,000 people/km². It contains several large multi-family housing estates and single-family housing. Zone C is inhabited by approximately 15% of the city's population, with a population density of less than 500 people/km². The buildings visible in this area are of a rural and ruralist with transformations nature.

Green areas in the city structure

To identify areas of Rzeszów with good access to previously selected landscaped green spaces, zones were designated covering the city area within a 5-minute walk. A person walking at a speed of 5-6 km/h covers 400 m to 500 m in five minutes. This lower value was adopted on the premise that most pedestrian routes are not straight. After superimposing these zones on a population density map, distinct areas were observed where access to green spaces is difficult due to distance. The study shows that the historic Old Town is almost entirely encompassed by good access to public parks. This accessibility may help mitigate the risk of depopulation and thus foster the preservation of the city's historic fabric. A graphical representation of the resulting analysis is presented in Figure 4. It is worth noting that forest areas, with the exception of one small area north-east of the city center, are generally not easily accessible from any high-density neighborhood. Sections of densely populated neighborhoods lacking adequate access to city parks are delineated with red outlines (Fig. 4).

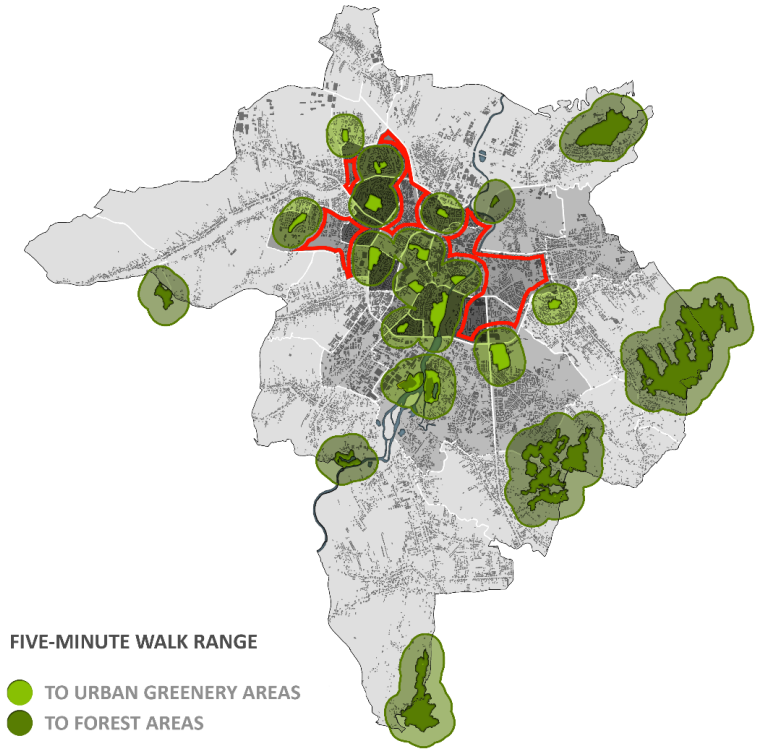

Fig. 4. Analysis of the accessibility of Rzeszów's green areas

Residents of these areas of the city should be considered disadvantaged by the low availability of high-quality public green spaces. Filling the identified gaps in urban green spaces should be a priority planning action. Further analysis could demonstrate the feasibility of creating large urban parks near these locations, providing residents with the full range of benefits derived from contact with nature.

Conclusions

In the context of the urban green space system, relying solely on area-based indicators published by the Central Statistical Office (GUS) does not provide a comprehensive picture of actual green space coverage in the city. When selecting methods for assessing accessibility, it is essential to consider both the functional characteristics of green areas and the diversity of residents' needs they are intended to serve. Ensuring good access to urban parks across the entire historic city center may help maintain its urban fabric by reducing the risk of depopulation. Although the overall situation appears relatively favorable, certain neighborhoods in Rzeszów exhibit markedly poorer access to multifunctional urban green spaces, while others are comparatively advantaged. Achieving more balanced accessibility across the city seems feasible, provided that careful attention is given to the location of green areas. Where the creation of large, multifunctional parks is not possible, smaller spaces—such as pocket parks—may serve as substitutes. While they cannot fully provide the same range of benefits and services, their higher density and strategic distribution can effectively complement the broader urban green space system.

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