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Accessibility to park in Łódź in view of individual transport, public transport and cycling

Abstract: In this article, the goal was to assess spatial accessibility to the parks in Łódź for example of cycling, individual transport and public transport. Parks represent basic units of recreational greenery in the city. (Czerwieniec, Lewińska 2000). In Łódź are 43 parks, which are located mainly in the rail peripheral or right behind her (Jakóbczyk-Gryszkiewicz 2008). To determine the spatial accessibility to the parks in the analyzed city, were calculated the number and percentage of the population, which living in 2016 in isochrones: 0-5; 5-10; 10-15; 15-20; 20-25; 25-30 minutes from the parks. In the study were taken into account the different means of transport - car, bicycle and public. It was found that the most beneficial for the residents of the city is by bike. In the case of 3/4 of the population of Łódź travel time by bike to the park is less than 5 minutes. Bicycle and public transport provide access to the parks, the vast majority of inhabitants of the city in time to 5 minutes, while individual transport in time 5-10 minutes. Most preferably, due to the accessibility for the residents of the city, are located parks in the city center, and behind its borders, in turn, within the rail perimeter. Over there the population density is greatest, unfortunately, a small area of parks.

Keywords: Transport accessibility; Parks; Łódź.

Introduction

The city has various functions, including residential, service, production, commercial, cultural, entertainment, tourist and recreational. It is a place of spending free time for its residents. Therefore, the city's infrastructure and its layout must be organized in such a way that people can spend their free time not only in home and private private space, but above all in public space, prepared for a mass audience. The most important elements that build the layout of the city's public space include green areas (Jakóbczyk-Gryszkiewicz, Tanaś 2008). They perform various functions: ecological - biotic, ecological soil, climatic, hydrological, pollution and social - aesthetic, recreational, recreational, didactic (Czerwieniec, Lewińska 2000; Szumacher 2011). Green areas play not only the most important role in shaping the natural space of the city (Bożętka 2008), but also affect the living conditions of its inhabitants (Bonaiuto et al. 2003, Chiesura 2004, Mierzejewska 2004, Tyrväinen et al. 2007, Comber et al. 2008) . However, according to Mierzejewska (2004), the role of green areas in a city depends on their number and distribution, while in the case of assessing the living conditions of residents, access to them from the main housing units of the city is also important.

Spatial accessibility is determined by the possibilities of communication and allows the use of various types of activity by a person permanently living in a certain area (Śleszyński 2004 for: Taylor 1999). The possibilities are in turn defined by the time of arrival, distance or costs related to the journey. It should also be emphasized that from the point of view of individual human units, spatial accessibility differs significantly from the temporal, social and economic availability. Therefore, there is no single universal availability indicator and therefore simplification is necessary in the studies (Śleszyński 2004). In this article, the objective is to assess the spatial availability of parks in Łódź in the light of bicycle transport, individual car and local collective transport. Parks are basic recreational greenery units in the city (Czerwieniec, Lewińska 2000). Greenery affects the psyche and health of residents (Nielsen, Hansen 2007; Maas et al. 2006; Maas et al. 2009; Van Den Berg et al. 2010), which is particularly important in the case of parks, as their potential users are people of non-productive age, including older ones (Jakóbczyk-Gryszkiewicz 2008). The research procedure presented in the article is one of the elements of the analysis performed for the purpose of diagnosing the accessibility of the inhabitants of Łódź to the local public transport carried out for the City of Łódź Office.

Characteristics of the research area

Until the turn of the 18th and 19th centuries, the area of today's Łódź was heavily forested (forests constituted about 72.3% of the city's area). It was dominated by mixed and pine forests, which complemented the oak-hornbeam, riparian and alder forests. In the 19th century, the process of industrialization of the city began, which led to its deforestation. In the 1850s, the share of forests decreased by half (Matczak 1994). At that time, the city developed parks, which was also noticeable in other large urban centers in Poland. During the wars and in the interwar period, there was stagnation in the development of green areas. In the years 1950-1990, the development of greenery was noticeable. Łódź is perceived as a "green" city compared to other centers in Poland (Niewiadomski 2013). The analyzed area, in comparison to other voivodship cities in Poland, ranks 6th in terms of the area of green areas per one inhabitant (which is also affected by the decreasing number of inhabitants of Łódź). In turn, the largest absolute area of green areas, among the analyzed collection of cities, is in Warsaw and Poznań (tab. 1).

Tab. 1. Structure of green areas in provincial cities of Poland in 2014

| S. N. | City | parks (ha) | Green squares (ha) | street greenery (ha) | green areas in housing estates (ha) | cemeteries (ha) | municipal forests (ha) | green areas in general (ha) | share of green areas in the city's area (%) | The surface of green areas (m ²) per capita |
|-------|-----------|------------|--------------------|----------------------|-------------------------------------|-----------------|------------------------|-----------------------------|---|---|
| 1. | Warszawa | 930,24 | 206,87 | 1189,77 | 11913,09 | 372,11 | 133,09 | 4745,17 | 9,17 | 27,34 |
| 2. | Kielce | 72,95 | 4,58 | 140,00 | 251,74 | 43,60 | 80,55 | 593,42 | 5,41 | 29,84 |
| 3. | Rzeszów | 81,62 | 63,75 | 218,00 | 166,38 | 48,54 | 9,00 | 587,29 | 5,05 | 31,72 |
| 4. | Białystok | 112,34 | 16,17 | 229,32 | 377,14 | 93,50 | 234,63 | 1063,10 | 10,41 | 35,98 |
| 5. | Katowice | 663,40 | 49,10 | 49,80 | 325,67 | 77,20 | 29,60 | 1194,77 | 7,26 | 39,58 |
| 6. | Lublin | 176,40 | 105,00 | 471,00 | 555,25 | 76,10 | 0,60 | 1384,35 | 9,39 | 40,51 |
| 7. | Kraków | 397,4 | 367,93 | 603,23 | 787,91 | 136,68 | 856,80 | 3 | 9,64 | 41,34 |

| | | | | | | | | | | |
|-----|---------------------|---------------|--------------|---------------|---------------|---------------|----------------|----------------|--------------|--------------|
| | | 0 | | | | | | 149,95 | | |
| 8. | Gorzów Wielkopolski | 138,30 | 120,50 | 73,94 | 94,13 | 38,13 | 49,20 | 514,20 | 6,00 | 41,42 |
| 9. | Gdańsk | 218,70 | 152,00 | 223,00 | 404,56 | 92,80 | 1045,20 | 136,26 | 8,15 | 46,29 |
| 10. | Wrocław | 828,28 | 130,33 | 547,26 | 446,71 | 141,17 | 896,49 | 990,24 | 10,21 | 47,13 |
| 11. | Opole | 182,50 | 5,00 | 216,00 | 115,22 | 44,70 | 13,90 | 577,32 | 5,98 | 48,28 |
| 12. | Toruń | 57,40 | 48,00 | 121,00 | 241,25 | 84,90 | 472,00 | 1024,55 | 8,85 | 50,43 |
| 13. | Łódź | 623,02 | 78,86 | 456,00 | 907,57 | 224,50 | 1461,78 | 3751,73 | 12,79 | 53,14 |
| 14. | Bydgoszcz | 879,40 | 71,60 | 287,10 | 535,63 | 98,90 | 157,10 | 1029,73 | 11,53 | 56,75 |
| 15. | Zielona Góra | 24,00 | 9,00 | 126,00 | 138,79 | 28,80 | 563,12 | 889,71 | 15,25 | 74,82 |
| 16. | Poznań | 347,30 | 94,60 | 950,00 | 608,76 | 252,00 | 154,80 | 407,46 | 16,83 | 80,77 |
| 17. | Szczecin | 161,50 | 46,66 | 207,20 | 232,15 | 204,05 | 472,30 | 323,86 | 11,06 | 81,63 |
| 18. | Olsztyn | 84,43 | 23,35 | 119,80 | 209,46 | 80,97 | 298,15 | 816,16 | 20,56 | 104,48 |
| | average | 332,18 | 88,52 | 346,02 | 461,75 | 118,81 | 662,68 | 2009,96 | 10,20 | 51,75 |

Source: GUS, access: 20.08.2016 r.

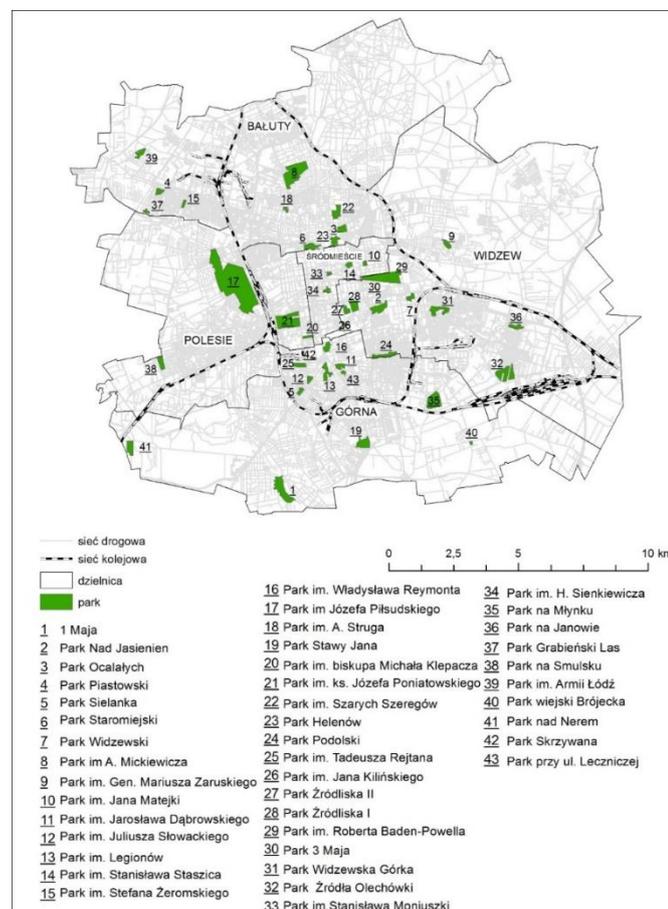
In Łódź, by far, the largest area falls on forests, which is associated with the presence of the Łagiewnicki Forest in the northern part of the city and on the estate green areas. In this classification, the parks are in third place - 623 ha (Central Statistical Office, 2014). Within the analyzed city, as of 31.12.2015, there are 43 parks that are unevenly distributed (Figure 1), (Borowska-Stefańska 2016/2017), they are located mainly within the perimeter railway or just behind it (Jakóbczyk-Gryszkiewicz 2008). In addition, differences in their distribution are also visible within the districts of the city. The smallest number of parks is in Śródmieście - 4 and in Polesie - 5. However, it is in Polesie that their area is the largest, because there is the largest park in Łódź - named by J. Piłsudski (Nowak 2006; Jakóbczyk-Gryszkiewicz 2008). In Śródmieście, the smallest surface parks are located. However, the most numerically discussed green areas are arranged in Widzew - 13, Górna - 11 and Bałuty - 10. They also have a similar area, totaling over 100 ha (City Hall 2016).

Parks in Łódź are characterized by good transport accessibility. The streets where they are located usually have at least one bus line, often including a tram (Fig. 2), (Jakóbczyk-Gryszkiewicz 2008).

The local collective transport, operated by the MPK municipal carrier, consists of two complementary systems (in particular in the city center and along the main roads) of substitutionary bus and tram systems. Transport is provided by nearly 80 bus routes and 22 tram lines that serve Łódź and neighboring municipalities (mainly bus transport, in three directions also by tram). Night transport is served by eight bus routes and recently also by one tramway. Local collective transport in Łódź is a total of about 2 thousand stops within the city limits and over 200 outside it (Figure 2). In addition, there are currently 100 bicycle

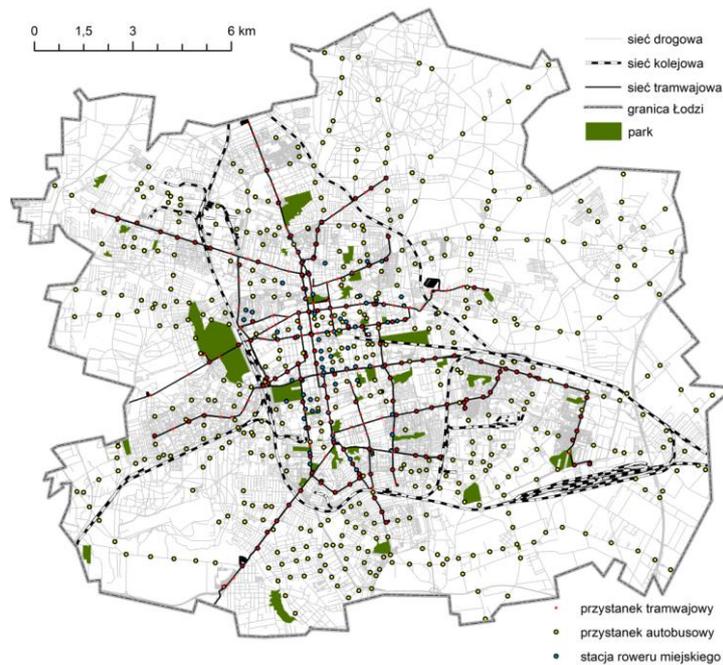
stations in the city with a total of over 1000 bicycles. These stations are located primarily in Śródmieście (www.zdit.uml.lodz.pl).

According to data provided by the City Hall of Łódź, in the first quarter of 2016, there were 658 573 people in Łódź, of which the working age population was definitely dominant - 57.5%. On the other hand, the share of residents in the post-working age was 27.67%, which is twice as much as in the pre-working age. Generally, it should be stated that parks are located in residential areas. As stated in the studies of M. Borowska-Stefańska (2016/2017), more than half of Łódź residents live in the pedestrian access isochron to 15 minutes. The best pedestrian access is characterized by the Old Town Park and Podolski Park. Whereas the fewest residents reside near Park nad Nerem, Park na Młynku, Park Armii Łódź, or Park Wiejski Brójecka and Park 1 Maja (Figure 3), (Borowska-Stefańska 2016/2017). Therefore, it is in the case of parks located away from residential buildings, that individual, collective or bicycle transport plays the most important role.

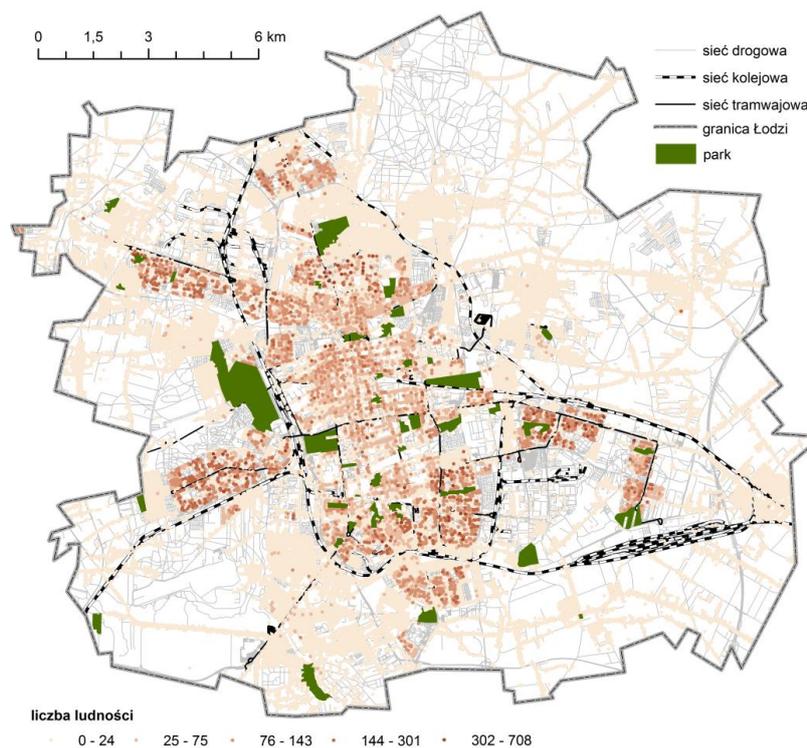


1. The distribution of parks in Łódź against the background of the transport network

Source: own study



2. The distribution of parks against the background of the Łódź transport network
Source: own study



3. Parks on the background of population distribution in Łódź. *Source: own study*

Methodology of research

There are many items in the literature that show the number of opportunities (access to specific functions, including rest areas) existing at some distance or some distance away from where they live (Taylor 1999). In the field of research methods, the use of cumulative (isochronous) accessibility was widely used in works devoted to collective transport and individual accessibility analysis. This type of availability is measured by estimating a set of

travel destinations available at a specific time, at a certain cost or effort of travel (Rosik 2012). To determine the spatial availability of parks in Łódź, the number and percentage of the population residing in 2016 in the 0-5 isochrones were calculated; 5-10; 10-15; 15-20; 20-25; 25-30 minutes from parks, taking into account various means of transport - individual car, public, and bicycle. The times of vehicles' journeys of local carriers between individual stops have been determined based on their websites. Data on the road network for the study was introduced on the basis of the Emapa Transport Plus Europa application and, if necessary, was supplemented with information obtained from OpenStreetMap resources. Each section of the city's linear road infrastructure has attributes attributed to its length, the maximum speed allowed for its traffic regulations, theoretical travel time (determined on the basis of the adopted maximum speed) and possible "one-way."

The next part of the study focuses on determining the temporary availability of parks in Łódź, assuming that the potential passenger of the train arrives at the stop with his own car. The next isochrones were drawn up assuming that the driver moves with the maximum speed allowed at a given section, along the path of the shortest travel time, taking into account the entry bans in one-way streets (Wiśniewski 2015).

The last part of the analysis concerns the availability of temporary parks in Łódź, assuming that the resident reaches them by bicycle. The General Directorate of National Roads and Motorways (Kopta et al., 2012) assumes that an efficient cyclist moves at a speed of 20 km / h. However, in the present study, the average speeds used in the studies of by M. Beim (2003) or M. Hyła (2001), according to which bicycle transport is carried out at an average speed of 14-16 km / h (so 15 km / h was assumed). The isochrones were drawn, assuming that the cyclist is moving along the path guaranteeing the shortest (in units of length) section to pass. The Manhattan certificate was used for both car and bicycle transport. It should be noted that the analyzes were carried out only for parks within the borders of Łódź, they did not include the areas of neighboring communes, to which residents of peripheral areas of the city can commute, who want to use the green areas.

To perform the calculations it was necessary to use the network analysis tool in GIS. For each building (address) within the city, a central point was generated and the number of inhabitants was assigned according to the data of the City of Łódź Office for the first quarter of 2016. Also for parks, their geometrical measure was determined, from which the calculations were made (isochrones were created). The studies did not take into account, in the case of gated parks, enter them. Therefore, the analyzes carried out constitute a certain simplification, they are the most appropriate for small parks, in addition to those that are unfenced, which in Łódź is the most.

Results

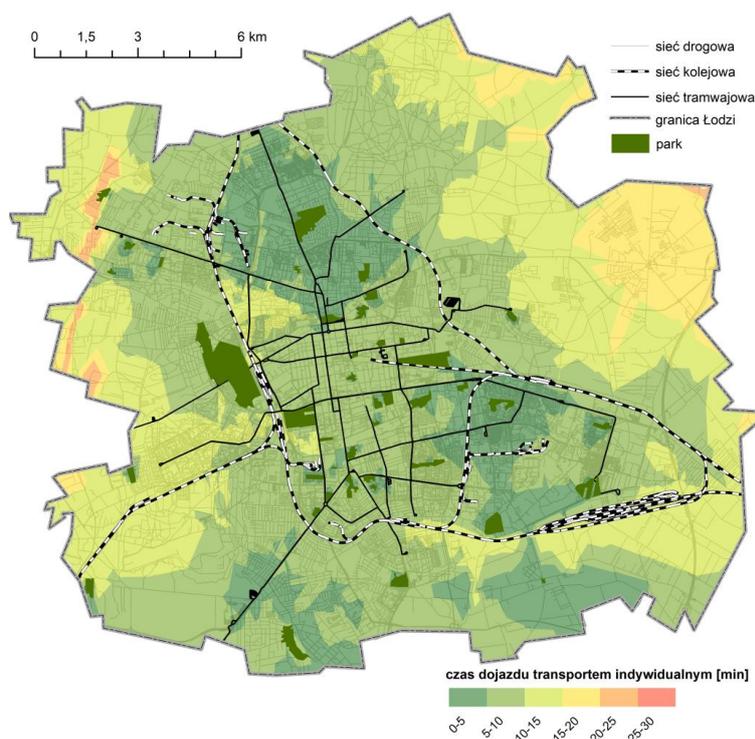
Car individual transport

When analyzing the travel time to parks by car, it should be stated that it does not exceed 25 minutes. Most people live in the isochrone 5-10 minutes from the park - 57.5% of inhabitants (of which pre-working age is 8.4% of residents, in production is 37.1%, and post-working 12%). It should also be emphasized that almost 30% of Łódź residents need only 5 minutes to reach the park. In total, as many as 99.3% of residents reside in the isochrone up to 15 minutes from the parks (Table 2). In the case of parks furthest from residential buildings, the time of access by car is very diverse. The best accessibility in this respect is the Park na Młynku and the Park wiejski Brójecka. To Park nad Nerem and Park 1 Maja, the time needed to reach the car is up to 10 minutes, only in the case of Park im. Armii Łódź is up to 25 minutes (Fig. 4).

Tab. 2. Number and share of residents of Łódź, who reside in the isochrones up to 30 minutes from the parks in the first quarter of 2016

| transport type | travel time | 0-5 | 5-10 | 10-15 | 15-20 | 20-25 | 25-30 |
|----------------------------|-------------|--------|--------|-------|-------|-------|-------|
| car individual transport | population | 191570 | 378430 | 83778 | 4324 | 471 | 0 |
| | share[%] | 29,1 | 57,5 | 12,7 | 0,7 | 0,1 | 0,0 |
| local collective transport | population | 400877 | 212425 | 15676 | 16180 | 6037 | 3922 |
| | share [%] | 60,9 | 32,3 | 2,4 | 2,5 | 0,9 | 0,6 |
| bucycle | population | 385837 | 210200 | 50260 | 7325 | 2625 | 1688 |
| | share [%] | 58,6 | 32,0 | 7,6 | 1,1 | 0,4 | 0,3 |

Source: own study based on data from the City of Łódź Office.

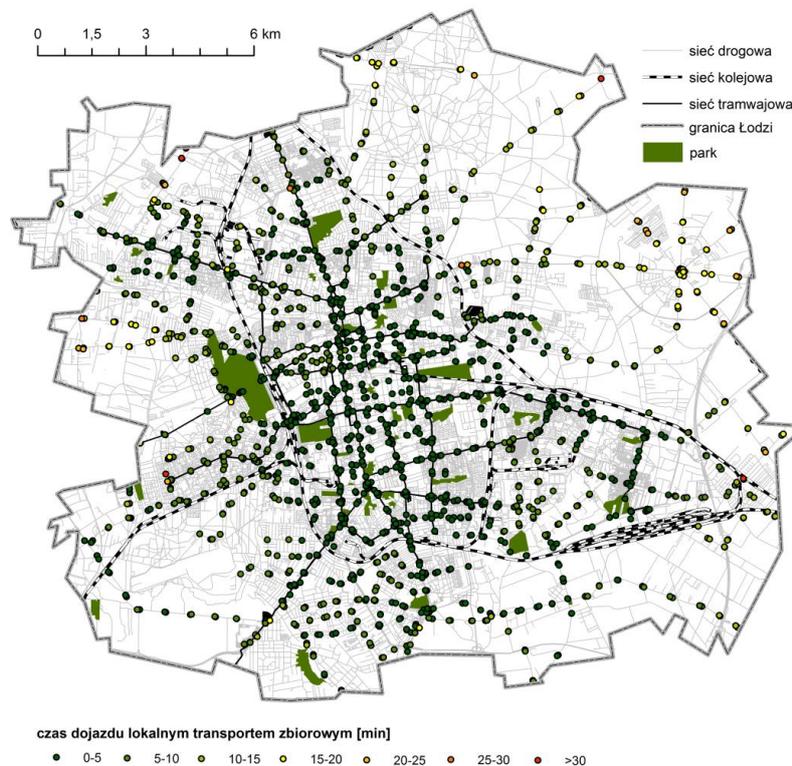


4. Spatial diversification of the temporary transport accessibility of parks in Łódź with the assumption of individual transport. Source: own study

Collective transport

When analyzing the availability of parks in Łódź, the local public transport should state that in the case of 99.5% of Łódź residents, this time does not exceed 30 minutes. However, as many as 93.2% (13.4% of people in the pre-working age, 59.6% of people of working age, 20.1% of post-working age people) live in the isochrone to 10 minutes from parks (Figure 5), (Table 2). The farthest from the public transport stops are located Park im. Armii Łódź and Park nad Nerem.

Most people are able to travel by collective transport within 15 minutes to parks located inside the perimeter railway. However, it is there that the parks are the smallest (mainly in Śródmieście). The smallest number of people at this time is able to get collective transport to parks located in the north-western part of the city - Park im. Armii Łódź, Park Grabiński Las, Park Piastowski and also in the south-west - Park nad Nerem, Park 1 Maja, Park na Smulku and south-east - Park wiejski Brójecka, Park Źródła Olechówki. They are located on the outskirts of Łódź, far from residential buildings, so also collective transport is not well organized there, as there are no potential users. However, if you want to rest, you need peace and quiet should visit the parks, which have the least access (Park 1 Maja, Park Źródła Olechówki, Park na Smulku, Park Armii Łódź, Park nad Nerem) and very large parks, i.e. J. Piłsudski's park, Park im. A. Mickiewicza, because it is there that the surface per one user is the largest (Fig. 6).



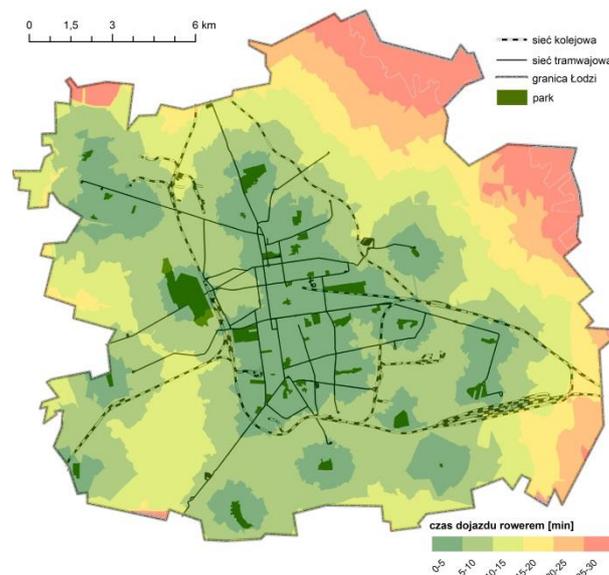
5. Spatial diversification of the temporary transport accessibility of parks in Łódź, assuming local public transport. *Source: own study*



6. Spatial differentiation of the absolute and relative "load" of parks in Łódź, assuming local mass transport in the isochrone up to 15 minutes. *Source: own study*

Bicycle

In the case of access to parks by bicycle, this time for 90.6% of residents does not exceed 10 minutes. Most people - 385 837, lives in the isochrone 0-5 minutes from the analyzed greenery areas, of which 39% are people of non-productive age. (Fig. 7), (Table 2). Similarly to the availability of collective transport, most people are able to go by bike within 15 minutes, to parks located in the city center. The weakest access for residents is the parks located on the outskirts of Łódź. Therefore, it is in Park nad Nerem or Park 1 Maja that the largest area of this area is calculated per 1 inhabitant. Equally beneficial are the visitors to J. Piłsudski's park, which results from its huge, compared to other gardens in Łódź, area (Figure 8). Of course, young people and children are especially able to use the bicycle.



7. Spatial diversification of the temporary transport accessibility of parks in Łódź with the assumption of cycling. *Source: own study*



8. Spatial differentiation of the absolute and relative "load" of parks in Łódź with the assumption of cycling in the isochrone up to 15 minutes. *Source: own study*

Conclusions

When analyzing the accessibility of parks, both individual and collective transport, as well as cycling, it should be stated that bike is definitely the most advantageous for city residents. In the case of $\frac{3}{4}$ of Łódź, the time of driving to the park by bicycle does not exceed 5 minutes. Bike and public transport provide access to the parks of the vast majority of Łódź residents within 5 minutes, while car transport in 5-10 minutes. Most advantageously, due to the accessibility for the residents of the city, there are parks in the city center, and just beyond its borders, within the perimeter railway. It is there that the density of population is the largest, unfortunately, the area of parks is small. Parks located on the outskirts of the city are characterized by poor accessibility for residents, in particular when it comes to public transport, but also an individual car. In their case, residents should reach them by bicycle. Their location is convenient in particular for people who value peace and quiet, who plan to rest and relax in the park.

Residents wanting to reach the park should choose a bicycle or a means of public transport (if they are not able to walk), because it is consistent with the sustainable transport policy for years, whose task is to counteract the negative effects of motorization growth (Brzeziński, Rezwow 2007). This is particularly important because the parks, which have the largest number of inhabitants in Łódź within 15 minutes, are located in the city center. It is for the implementation of these assumptions that there are docking stations in the city limits of Łódź, where you can rent a city bike (they are located mainly within the city center). In addition, the city authorities are constantly trying to develop bicycle paths. Actions are also taken to promote collective transport. Thanks to this, environmentally friendly transport means become more competitive in relation to individual vehicles (Nosal, Starowicz 2010).

Analyzes carried out in this article should be used by the city authorities, both when planning new urban green areas, as well as during conceptual work on the local transport system. Of course, these considerations should be enriched with the distribution and characteristics of the remaining green areas both within the borders of Łódź and in the areas of neighboring gminas. Because the administrative border of the city does not matter in the case of using public spaces. It is noticeable only in the case of the operation of local public transport. The density of stops, the number of lines and the frequency of running of vehicles

drops significantly in the case of routes running outside the city limits, limiting the availability of Lodz residents to green areas outside the city and residents of neighboring municipalities reaching Łódź parks.

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