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The use of GIS network analysis methods that assess the availability of places of open physical activity in Bydgoszcz

Wykorzystanie metod analizy sieciowej GIS do oceny dostępności miejsc otwartej aktywności fizycznej w Bydgoszczy

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ABSTRACT

Development of an analysis of the availability of physical activity for the inhabitants of Bydgoszcz using the methods of GIS network analysis. A characteristic feature of the development is the use of network analysis methods commonly used instead of the methods for estimating the distance based on the buffers. Thanks to the technology used, obtained communication availability of land sports and recreation for individual areas of the city. Considerable differences in the availability of open areas of physical activity in Bydgoszcz, some areas located in the city center, in a significant concentration of the population has a very good accessibility. Worst availability located in areas characterized by a predominance of the production function and significant areas of forest.

Key words: GRASS GIS, Bydgoszcz, network analysis, the open space of physical activity.

ABSTRAKT

Opracowanie stanowi analizę dostępności miejsc aktywności fizycznej dla mieszkańców Bydgoszczy przy wykorzystaniu metod analizy sieciowej GIS. Charakterystyczną cechą opracowania jest wykorzystanie metod analizy sieciowej zamiast stosowanej powszechnie metody oceny odległości na podstawie buforów. Dzięki wykorzystanej technice, uzyskano komunikacyjną dostępność terenów sportowo-rekreacyjnych, dla poszczególnych obszarów miasta. Stwierdzono znaczne zróżnicowanie dostępności do obszarów otwartej aktywności fizycznej na terenie Bydgoszczy, część obszarów położonych w centrum miasta, w miejscach znacznej koncentracji ludności charakteryzuje się bardzo dobrą dostępnością. Najgorsza dostępność znajduje się na terenach charakteryzujących się przewagą funkcji produkcyjnej oraz na znacznych powierzchniach leśnych. Badania wykazały możliwość zastosowania analizy sieciowej w badaniach z zakresu analiz gospodarki przestrzennej dla dynamicznie rozwijających się miast.

Słowa kluczowe: GRASS GIS, Bydgoszcz, analizy sieciowe, miejsca otwartej aktywności fizycznej.

INTRODUCTION

The article presents the results of analysis of the availability of physical activity for the inhabitants of Bydgoszcz. Examined the city is characterized by a high share of green areas in public spaces, distinguishing them in Polish scale. Forest areas on each side surrounded Bydgoszcz, and occupy 32% of the surface (5 630 ha). They are mostly protective forests. In turn, parks and public green spaces occupy a combined area of over 879 hectares, or almost 5% of the area of the city.

A multitude of green areas in Bydgoszcz physical activity promotes a significant population. This activity is conditioned also by the presence of sports and recreational infrastructure, which include sports fields of "Orlik" (Fig. 1). They are most often football field with artificial turf, basketball, volleyball and tennis courts) and open gyms (Fig. 2). All of these types of objects are small zone of sports and recreational infrastructure, allowing interested parties free access to the equipment supporting physical activity.

Different types of activities residents are defined by the planning authorities as "green

space hierarchy to use social" because they have to provide the specific functions of a particular group of users. For example, playgrounds for small children meet the daily needs of children at a young age and are very important for their overall development. In children in early age it was found a positive correlation between exposure to green space and cognitive development (Grupta et al., 2016). Cited authors also point out that the proximity of the park and the community that uses it that makes people have better relationships with family members, and the proximity of the park or natural areas creates an opportunity for weekend recreation for the whole family (Grupta et al., 2016).

M. Lindberg and J. Schipperijn (2018) observed, in turn, that the use of open physical activity relates mainly to young people, it may mean that among teenagers are preferred devices to enable certain types of games or play area along with their peers in this regard, that activity physical has a positive impact on public health Gul et al. (2018). The proposed guidelines to facilitate obtaining the desired level of physical activity by walking or use of physical activity. According these authors availability of exercise equipment has a positive relationship with physical activity. At the same time authors cited it shows that in developed countries the type of gated communities called Lifestyle GCs (modern types of housing provide residents comfort in the form of car parks, places of physical activity, landscaping and fencing) provides more activity at the level of proximity in relation to places of residence and reside people (such as schools), prompting residents to be physically active.

The main objective of this study is to analyze the availability of open physical activity for the residents of the city, taking into account the existing network of road communication. Founding availability of activity based on the ability to use such sites without having to use public transport or their own, regardless of age, mobility and time constraints associated with, for example, limit the length of free time that can be spent on physical activity. Results of the study are an example of GIS techniques (network analysis) in research and presentation of data related to the availability of spatial objects analyzed, and may assist in decision-making processes concerning the creation of physical activity.

Examples of similar use of network analysis techniques are used mainly for studies of the river network. These studies were related to the assessment of the impact of external factors (such as urbanization, agriculture, natural obstacles and anthropogenic) systems showing a network system, these methods allow the determination of the development of river network (Jasiewicz and Metz, 2011, Neteler, et al., 2012 Young and Park, 2014).

Existing modeling methods associated with choosing the best route for each segment in the road network analysis, route planning, taking into account only the variable distance or time, do not give relevant results. It is anticipated that the use of other techniques such as network analysis process, it would be useful to overcome this problem (Sadeghi-Niaraki et al., 2011 Badiu et al., 2018).



Figure 1. Sports fields of "Orlik" (www.aktywna.bydgoszcz.pl, 2018)



Figure 2. Open gyms (Fig. Author)

TEST METHODS

It was awarded for the development of 52 objects open physical activity located in Bydgoszcz (including 33 sports fields and the gym 19). Location of objects was based on information posted on the website of the Municipal Office in Bydgoszcz (www.aktywna.bydgoszcz.pl, access in February 2018 years) And based on field inventory conducted in March 2018 year. Location of these objects has also been analyzed in conjunction with the immediate environment, in particular with regard to the remaining facilities in the immediate vicinity of schools. It should be noted, however, that the growing

interest, in particular, open gyms, significantly affects their dynamic growth and increasing from year to year the number of these objects.

The tests were performed using a GIS network analysis techniques allowing to analyze the data in terms of two-dimensional. The study used an artificial network model consisting of layers of lines and points. The second group of objects also include points that are assigned the information on the relationship topological linear and point (points and lines must have the correct topological relationships, be tangential to each other). This allowed the fusion of layers of lines and points in one coherent structure.applied method of calculation only takes into account the availability of validated communication network of the city, but does not take into account the availability resulting from the openness of the space and the possibility of using, for example, the paths in parks or open areas. Modeling based on network analyzes can lead to a new category of information, based on which we can make the necessary plans and decisions. Studies show that this method can be used as a tool to identify the functional hierarchy of the road network, in which the availability of objects is a helpful measure of interest in the identification of the main roads systems (Ahmadzai et al., 2018).

Past studies concerning the availability of specific places in the public space characterized by an analysis based on the distance buffer with a fixed distance (Koohsari et al., 2013, Villanueva et al., 2015) do not take account of the complexity of communication and technological barriers. As a result of network analysis obtained linear distances of objects sports and recreational infrastructure. The procedure was to determine the sections to implement GRASS GIS application of appropriate algorithms (R. Blazek, 2014):

v.net - Performs network behavior - is used to create and maintain relationships topological network. Its main use is to create a network of vector of vector lines (arcs) and points (nodes) by creating nodes of intersections on the layer of the line (an operator node), through a combination of map vector lines with the map points (operator call), and through the creation of new lines between pairs vector points (operator arcs);

v.net.iso - Splits network vector lines for coverage - the network bandwidth is divided between the lines need to use (the distance from the center). Central nodes must be open (the need to use ≥ 0). The calculations are used distance of the central nodes.

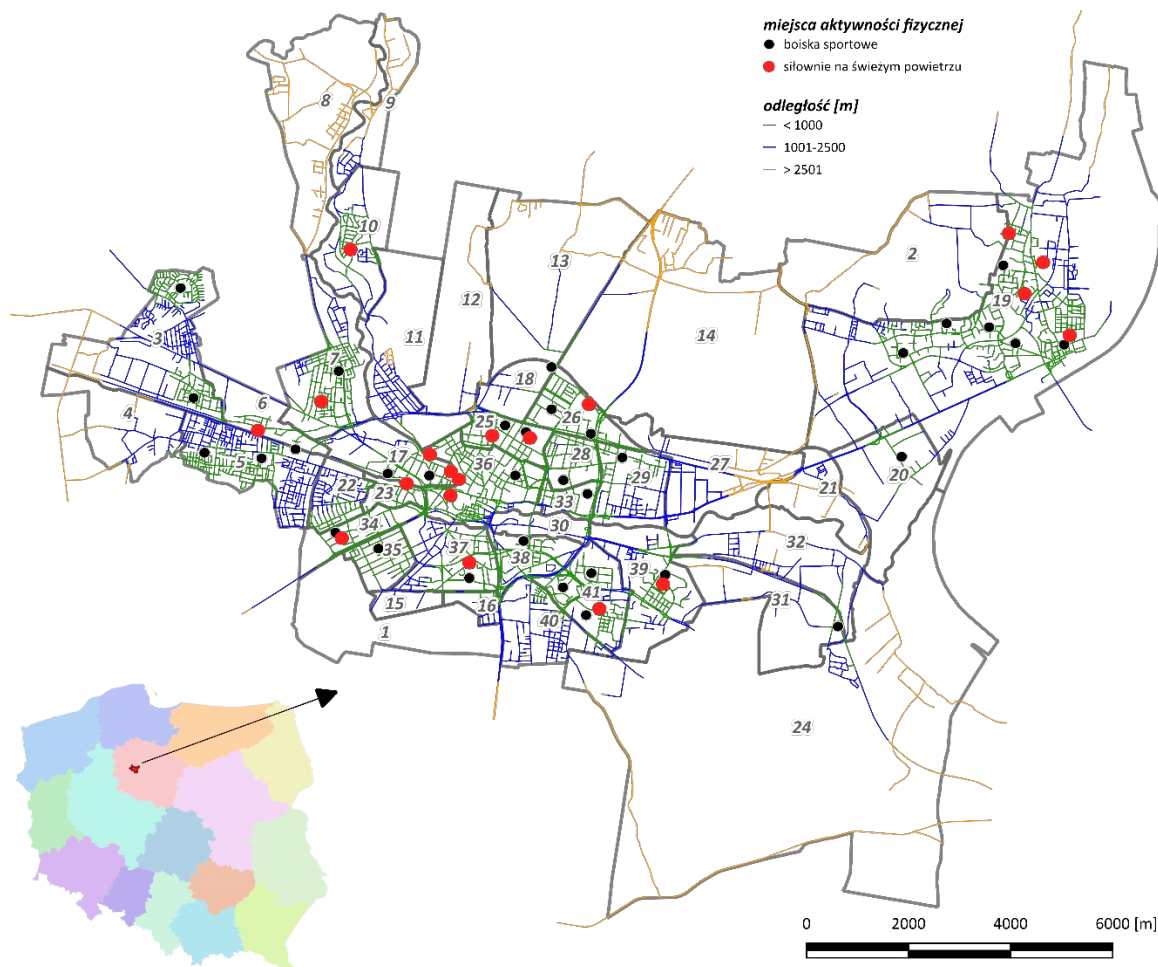


Figure 3. Analysis Network availability of physical activity in Bydgoszcz, including the communication network (Own work based on: urban communication network - OSM, 2018, the location of objects of physical activity. Districts Bydgoszczy 1 – Lotnisko, 2 - Górny Taras, 3 - Osowa Góra, 4 – Prądy, 5 – Miedzyń, 6 – Flisy, 7 – Czyżkówko, 8 – Oplawiec, 9 – Smukała, 10 – Piaski, 11 – Jachcice, 12 – Rynkowo, 13 – Myślęcinek, 14 - Las Gdański, 15 – Biedaszkowo, 16 – Bielice, 17 – Okole, 18 – Zawisza, 19 – Fordon, 20 – Brdyujście, 21 – Siernieczek, 22 – Jary, 23 – Wilczak, 24 – Łęgowo, 25 – Bocianowo, 26 - Osiedle Leśne, 27 - Bydgoszcz Wschód, 28 – Bielawy, 29 – Bartodzieje, 30 - Babia Wieś, 31 - Czersko Polskie, 32 - Zimne Wody, 33 – Skrzetusko, 34 – Błonie, 35 – Górzyskowo, 36 – Śródmieście, 37 – Swederowo, 38 - Wzgórze Wolności, 39 – Kapuściska, 40 – Glinki, 41 - Wyzyny

The effect was to determine the algorithms of network sections meet the requirements implemented in the analysis parameters. On the resulting map shows the resulting uniform color lines with a predetermined distance from the object (Fig. 3). It should be noted that due to network analysis, this presentation shows the real linear distance (communication) of the object, not areas with fixed distances (buffers).

For the purposes of analysis the area the distance of objects enabling free access population at a distance of 1000 m from the object, zones of limited access to objects - from 1000 to 2500 m from the object and the area of difficult access to objects - more than 2500

m, which can bind to require the use of additional means of transport to reach the property.

RESULTS AND DISCUSSION

The analysis helped to determine the areas of access to objects sports and recreational infrastructure in Bydgoszcz. Noticeable is the density of objects in concentration residence time residents of the city, for example in the areas of schools, where is located the majority of sports fields. A large concentration of these objects occurs primarily in the city center, the adjacent districts of multifamily housing (Upland, Kapuściska, Szwederowo, Osiedle Leśne) and in the district of Fordon. This can be associated with high population density of the city, as well as a significant number of schools. Limited availability zones are largely in the areas of single-family housing developments, where you create objects sports and recreational infrastructure is limited by the availability of space and land ownership structure (mostly private land). Areas with low availability of infrastructure discussed should be divided into two groups:

areas with limited availability of investment - woodland (Myślęcinek Las Gdanski, Oplawiec, Smukała)

areas performing other functions - mainly areas of the production function (Bydgoszcz Industrial and Technological Zone - Łęgowo) and communication-service (Bydgoszcz East, Brdyujście, currents).

Location designated zones of activity overlaps significantly with the structure of spatial planning and the city, which means continuity of the concept of sustainable development and care for the comfort of residents in spatial planning Bydgoszcz.

Change research equilibrated metabolic rate (MET) conducted in Finland shows that increasing the distance and reducing the number of sports facilities is associated with a decrease in physical activity, suggesting that changes in the availability of facilities may affect the level of physical activity (Halonen et al., 2018).

CONCLUSIONS

On the basis of network analysis can conclude that Bydgoszcz has a very good accessibility areas of physical activity, which is associated with the proper planning process of the city (decision-making about the location of open physical activity) and a large share of public green spaces in the city, which allows for collision-free locating these objects. Despite generally good accessibility to the analyzed objects, it has shown some zoning

availability of objects sports and recreational infrastructure, resulting from spatial and functional structure of the city, as well as the history of its expansion The study allowed us to identify sites that have a deficit of access to sports and recreation facilities.

It has been shown possible to use network analysis in research in the field of spatial analysis. In our case, to test methods included a specific category of objects associated with physical activity in the open, but the method can also be applied to the analysis of the availability of facilities of physical activity of another type, such as gyms and fitness clubs, swimming pools and sports halls and closed field, but also any other urban infrastructure facilities, eg. health centers, schools, cinemas, bus stops, etc.

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