UDK 630* 451 + 153 (001)
doi:10.31298/sl.142.9-10.4

Izvorni znanstveni članci – Original scientific papers
Šumarski list, 9–10 (2018): 487–497

ACCESSIBILITY ANALYSIS OF URBAN GREEN SPACES IN THE SETTLEMENT OF ZADAR IN CROATIA

ANALIZA DOSTUPNOSTI URBANIH ZELENIH POVRŠINA U NASELJU ZADAR, HRVATSKA

Silvija ŠILJEG[1], Ivan MARIĆ[1], Gojko NIKOLIĆ[2] , Ante ŠILJEG[1]

SUMMARY

Accessibility of urban green spaces (UGS) is an integral element of satisfying quality of life. Due to rapid urbanization, the studies about UGS are becoming one of the key elements of urban planning. Functional network transport system and optimal spatial distribution of UGS are preconditions for maintaining the environmental balance of the urban landscape. Accessibility analysis of UGS in the settlement of Zadar was conducted as a part of the *Urban Green Belts Project (UGB)*. Development of spatial database was the first step in generating UGS accessibility indicator. Data were collected using the supervised classification method of multispectral LANDSAT images and manual vectorization of high-resolution digital orthophoto (DOP). An analysis of UGS accessibility according to *Accessible Natural Greenspace Standard* (ANGst) was conducted. Accessibility indicator was generated based on seven objective measures which include the UGS per capita and accessibility of six UGS functional levels. The UGS accessibility indicator was compared with subjective measures that have been obtained by field survey of 718 respondents within 41 statistical units. The collected data reflected an individual assessment and subjective evaluation of UGS accessibility. This study illustrated the importance of using objective and subjective measures in the process of understanding UGS accessibility. It may be concluded that while evaluating accessibility, the residents emphasize the immediate residential environment, neglecting the UGS of higher functional levels. Furthermore, that large amounts of UGS within a city (114 m² per capita) do not necessarily generate a similar satisfaction with their accessibility. The output results may serve as guidelines for the further development of the functional UGS city network.

KEY WORDS: urban green spaces (UGS), accessibility indicator, subjective and objective measures, GIS.

1. INTRODUCTION
1. UVOD

Urban green spaces (UGS) are open, public or private areas in urban environments, mostly covered with vegetation, either directly or indirectly accessible to urban populations (Zadar Nova, 2016). Research has shown (Grahn and Stigsdotter, 2010; Van den Berg et al., 2010; Koc et al., 2017) that UGS stimulate physical activity and have a positive influence on the health and psychological well-being of urban residents. Many authors (Karavla, 2006; Litt et al., 2011; Jesdale et al., 2013) have provided examples of how UGS can regulate air and water pollution, mitigate urban heat effect and enhance the quality of food products in urban

[1] Doc. dr. sc. Silvija Šiljeg, Ivan Marić, mag. geogr., Doc dr. sc. Ante Šiljeg, University of Zadar, Department of Geography, Franje Tuđmana 24 i, 23 000 Zadar, Croatia. e-mail: ssiljeg@unizd.hr (corresponding autor), imaric1@unizd.hr, asiljeg@unizd.hr
[2] Doc.dr. Gojko Nikolić, University of Montenegro, Department of Geography, Danila Bojovića 3, 81400 Nikšić, Montenegro, e-mail: gojkorn@t-com.me

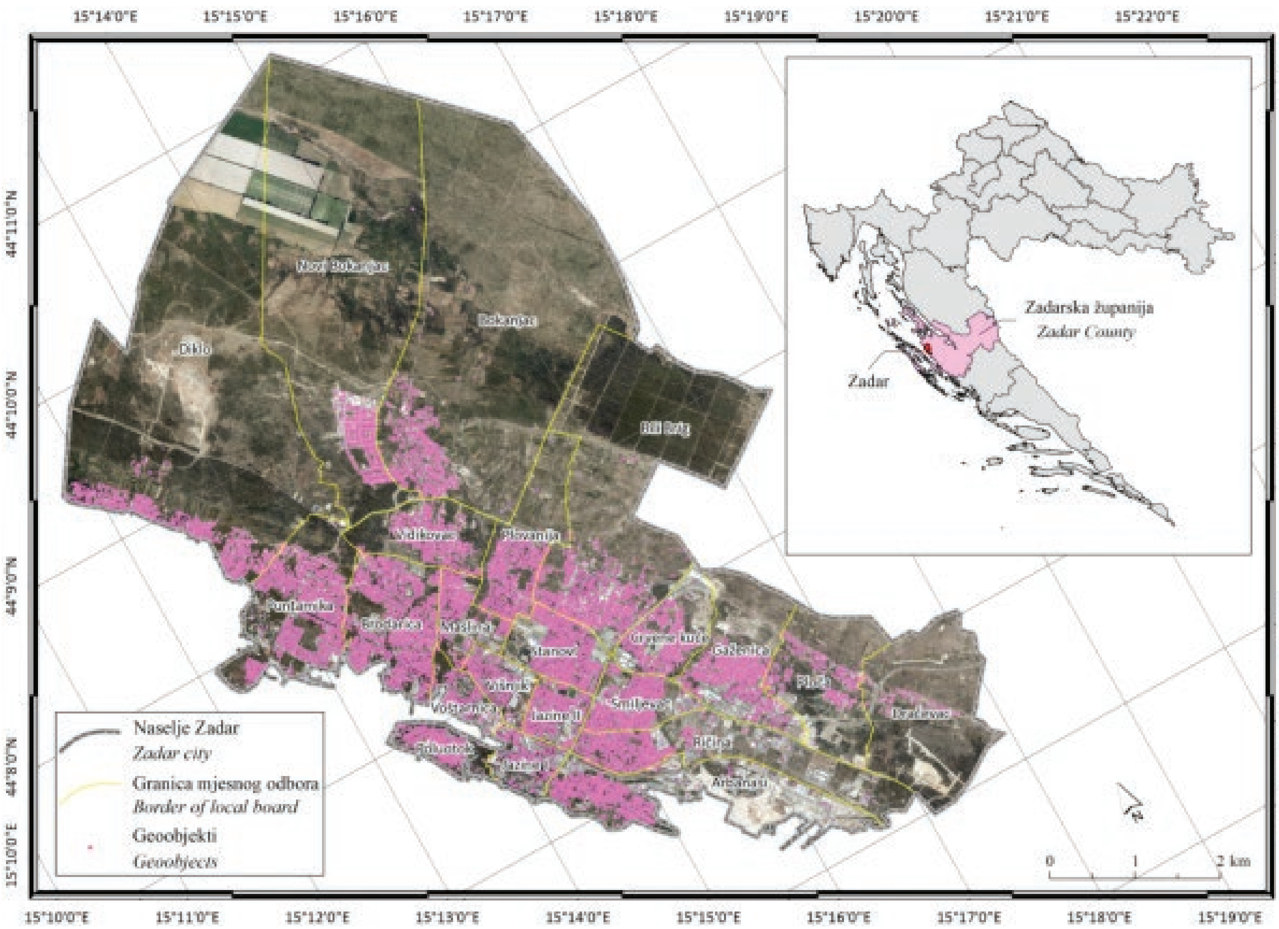

Figure 1. Geographical scope of the research
Slika 1. Prostorni obuhvat istraživanja

gardens, which can result in the improvement of urban residents' physical health (Jennings et al., 2016). According to Sandström et al. (2006) and Kong et al. (2010) the functional network of UGS contributes to the preservation of ecological balance and the sustainable use of biological resources. Optimal location and planning of green spaces, while taking into account the infrastructural and demographic needs of the city, have the potential to mitigate the negative effects of urbanization, fostering sustainable development, which ultimately makes the city more attractive by increasing the quality of life (Van Herzele and Wiedemann, 2003; Wolch et al., 2014; Gupta et al., 2016). Sandström (2002) states that UGS are necessary for the ecologically supportable function of cities, because of their influence on everyday recreation, the preservation of biodiversity (Gunnarsson et al., 2017), city's cultural identity, the maintenance and improvement of the overall environmental quality, and their contribution to technical problem-solving through natural solutions. Usually, public UGS are usually not equally and fairly distributed (Oh and Jeong, 2007; So, 2016), especially in the terms of their accessibility to different ethnic/religious groups, or people with different incomes (Germann-Chiari and Seeland, 2004; Jesdale et al., 2013). The spatial framework of the research was the settlement of Zadar (Fig. 1), which according to the 2011 Census of the population, households and dwellings had 71,471 inhabitants (Šiljeg, 2016). The level of data processing and UGS accessibility indicator modelling was the statistical circle*. The objectives of this research were to:

1) develop a GIS database of UGS for the settlement of Zadar according to the methodology of *Urban Green Belts Project (UGB) WPT 1 Activity 1.1* (Zadar Nova, 2016);
2) determine the UGS accessibility according to the *Accessible Natural Greenspace Standard*;
3) generate the UGS accessibility indicator on the basis of seven objective measures;
4) compare the derived indicator with the subjective perception of the population.

* Statistical circles are the smallest available spatial territorial units. They were created in 1959 and have been revised for each population census. They represent a permanent network of spatial units, which covers the entire mainland area of Croatia. The settlement of Zadar consists of 41 statistical circles.

In accordance with the defined objectives, the following hypotheses were posed:

a) the settlement of Zadar is a heterogeneous unit because there are significant differences in UGS accessibility and quantity among statistical circles;
b) large areas of UGS within the settlement do not necessarily generate equal satisfaction regarding their accessibility;
c) the perception of citizens and the UGS accessibility indicator coincide.

2. FUNCTIONALITY AND ACCESSIBILITY OF UGS
2. FUNKCIONALNOST I DOSTUPNOST UZP-A

Numerous empirical studies (Jim and Chen, 2006; Qureshi et al., 2010; Irvine et al., 2013) have indicated that UGS have specific functions at different levels of urban life. Urban forests can play a significant role in urban areas in the context of weekend recreation, while smaller parks located in the city centre have a stronger connection with local daily activities and socializing (Chiesura, 2004; Oh and Jeong, 2007). Since UGS accessibility aims to reflect community needs, it is important to consider different functional levels. The functional level means that green spaces of smaller (residential green) and larger areas (urban forest) cannot replace each other because residents perceive them in different ways and use them for different types of activities (Van Herzele and Wiedemann, 2003).

Accessibility is defined as "relative ease" of approach to specific attractive locations from certain places (Luo and Wang, 2003; Mak et al., 2017) and how visible the site is to the public. Accessibility usually refers to the non-linear distance travelled in the specific time unit without the use of means of transportation, from the user's location to his closest green space (So, 2016). Although the definition of accessibility is relatively simple, its implementation can be quite challenging, due to the characteristics of the city's transport network (Comber et al., 2008). In this paper, UGS accessibility is expressed as a percentage that represent the share of the population within specific statistical circle which has accessible specifically UGS functional level.

3. METHODS
3. METODOLOGIJA

The work methodology was based on the integration of general scientific and specific geomatic methods, which included a multispectral satellite image analysis using the supervised classification method, vectorization of high-resolution digital orthophoto (DOP) images, GIS spatial analysis, and statistical and cartographic visualization methods. The research process was designed and implemented in four stages.

The first phase of the research was related to analysis of the literature about UGS with the aim of determining standards based on which the accessibility indicator would be created. Seven objective measures for the evaluation of statistical circles were defined. These included: 1) UGS-a (m^2) per capita and 2-7) accessibility (%) according to UGS functional levels.

In the second phase of research the first full spatially oriented UGS database for the settlement of Zadar was created following the methodology of *Urban Green Belts Project (UGB) WPT 1 Activity 1.1* (Zadar Nova, 2016). The database was created using multispectral images (USGS, 2017) and the high resolution DOP images (DGU 2017). Supervised classification of LANDSAT 8 multispectral images, with a spatial resolution of 25 m, was performed and UGS were extracted from the settlement of Zadar. The derived model of land cover was modified and adjusted using data collected through the hand vectorization method of high-resolution DOP (pixel size = 0.5 m). The combination of different data sets delivers a higher value of output data, which provides more potential for analysis and a better interpretation of the model.

In the third phase, the objective measures required for generating the UGS accessibility indicator were derived from the created database. An accessibility analysis according to the Accessible Natural Greenspace Standard (ANGst) and UGS functionality level was performed using the non-linear distance and travel time variables. In this case, walking time (min.) and regular distance (m) were used as a cost attribute. The ANG standard was defined to evaluate access to UGS and identify statistical circles which lacked green space. According to this standard, and regardless of where they live, everyone should have access to UGS of at least 2 hectares, and not further than 300 metres or 5 minutes walking distance from their home (English Nature, 2003). Analysis was performed using the walking distance "cost" (min.) from geoobjects, which represented the urban infrastructure, to UGS access points (Comber et al., 2008; Gupta et al., 2016). UGS access points were determined by overlapping the traffic nodes and UGS layer with DOP. The functional levels of UGS were determined according to the size of their area (Van Herzele and Wiedemann, 2003) and their accessibility was determined based on the parameters of walking time following a systematic process:

a) From the UGS database, classes representing *residential green* (up to 1 ha), *neighbourhood green* (1-5 ha), *quarter green* (5-10 ha), *district green* (10-60 ha), *city green* (60-200 ha) and *urban forest* (>200 ha), were selected. Using the *Network Analyst* extension accessibility zones were produced around previously created UGS functional levels.

Šumarski list, 9–10, CXLII (2018), 487–497

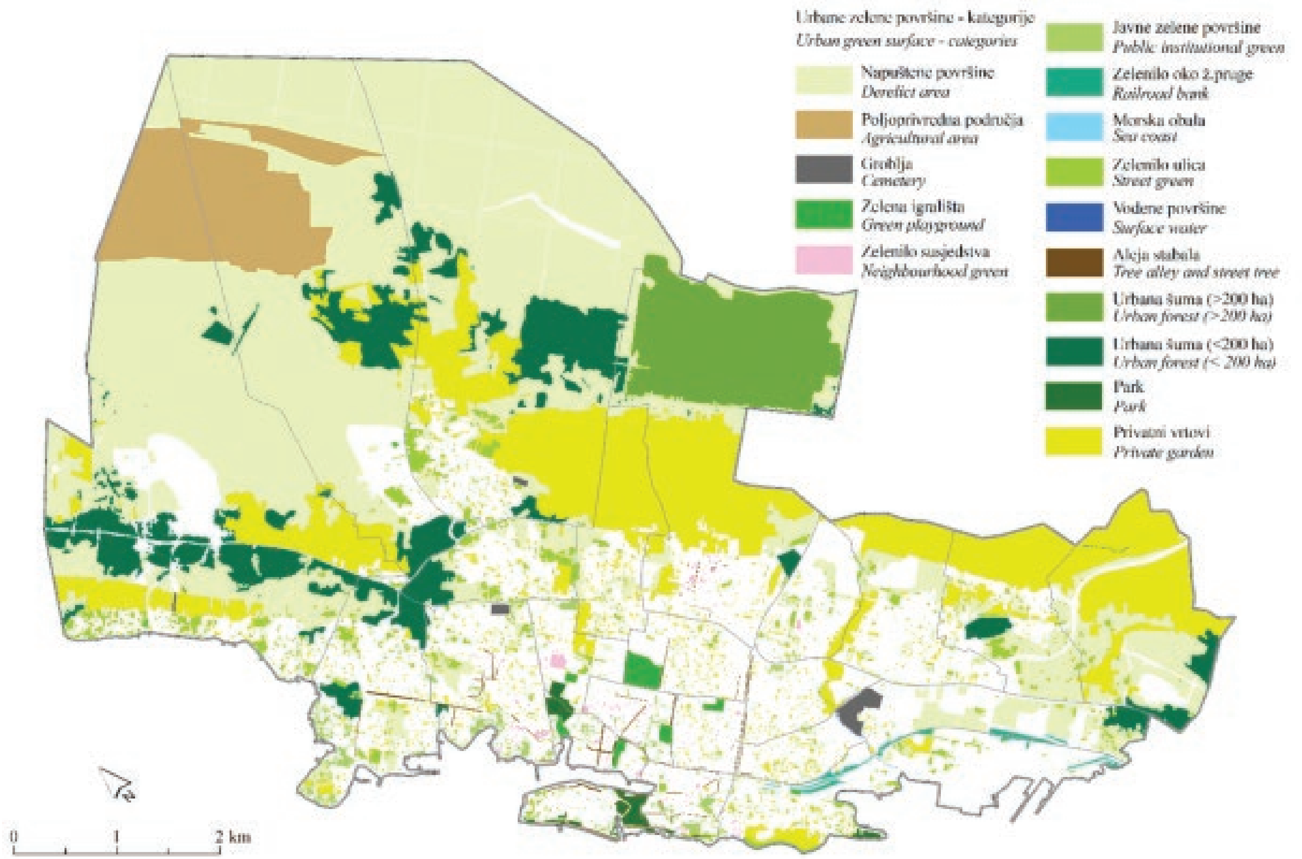

Figure 2. UGS in Zadar according to Urban Green Belts Project (UGB) classification
Slika 2. UZP-e u Zadru prema klasifikaciji Urban Green Belts Project (UGB)

b) Since the polygons representing areas of accessibility were irregular in shape, it was difficult to determine the proportion of population with accessible specific functional level of UGS. To address this limitation and obtain the most precise output results, data about population within a statistical circle and vector data about housing objects (Teodolit, 2017) for 2015 were used. The number of inhabitants for specific geoobjects was determined so that the total population of a particular statistical circle was divided by the number of geoobjects located in it. Adjustment of the created values was carried out according to the number of floors and official data on household sizes in Zadar County. A raster model of population density was created using the *Kernel Density* tool.

In the fourth phase of the research, the UGS accessibility indicator was derived from seven objective measures. Due to the complexity of the study and the subjective perception of UGS accessibility, the generated indicator was compared with subjective measures collected through a field survey which examined levels of population satisfaction with UGS accessibility in the settlement of Zadar. A field survey was conducted in 41 statistical circles in the settlement of Zadar between 10 May and 10 June 2014. In each statistical circle, 1% of the population, or 718 respondents were interviewed. Most of the questions were closed type and answers were given on the scale of five degrees, as follows: 1- *completely dissatisfied*, 2 - *mostly dissatisfied*, 3 - *neither satisfied nor dissatisfied*, 4 - *mainly satisfied* and 5 - *completely satisfied*.

4. RESULTS
4. REZULTATI

4.1 Creating a UGS database for the settlement of Zadar – *4.1. Izrada baze UZP-a za naselje Zadar*

A spatially-oriented UGS database for the settlement of Zadar was made following the official methodology of the project. The derived spatially-oriented database (Fig. 2) served to determine the objective measures required for the process of UGS accessibility indicator modelling. It is evident that green areas are spatially dominant, but not evenly distributed within the administrative borders of Zadar (Fig. 2). Specifically, the ratio of the built-up environment and green areas in the settlement of Zadar is 1:2.3. This is the consequence of the specific form of administrative border, which in the north and northwest includes large, undeveloped, derelict spaces that for the majority of the population are not functionally part of the city. Scrubland and derelict agricultural areas dominate in this area (Fig. 2).

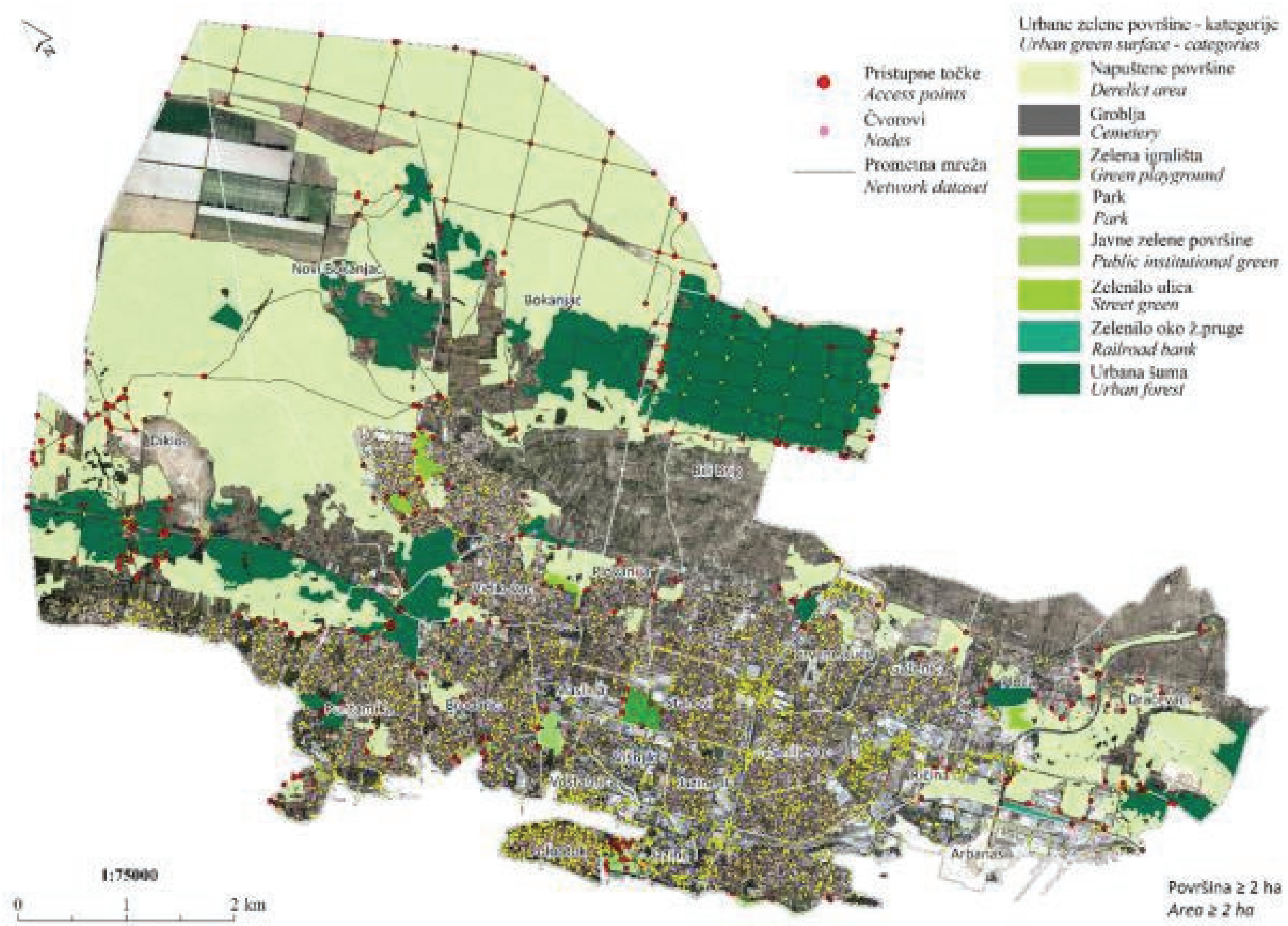

Figure 3. Selected UGS (area > 2 ha) with access points
Slika 3. Izdvojene UZP-e (površina > 2 ha) s pristupnim točkama

4.2 Accessibility analysis according to the ANGst standard – *4.2. Analiza dostupnosti prema ANGst standardu*

UGS accessibility was analysed according to the ANGst standard, proposed by the English Nature (2003). Following the approach of Barbosa et al. (2007), Comber et al. (2008) and Kuta et al. (2014) private gardens and agricultural areas were excluded from the accessibility analysis because they were not available to all inhabitants of the city. For each extracted UGS bigger than 2 ha, the access point was determined (Fig. 3).

Since in the ANGst document two variables of cost are listed (5minute of walking time and nonlinear distance of 300 m), zones of accessibility were created based on two cost attributes. According to Combert et al. (2008) and Sotoudehnia and Comber (2011), the most precise variable in the performance of the accessibility analysis is the walking time (min) to the UGS. Based on this variable statistical circles in which less than 10% of the population have an available green area (> 2 ha) within a five minute of walk are: 135356, 135364, 135372, 135399, 135402, 135429, 135500, 135518, 135526, 135615, 135623, and 135631. Statistical circles in which 0% of the population has an available green area (> 2 ha) within a five-minute walk, based on both cost attributes are: 135364, 135500, 135518 and 135526. According to the variable of walking time, in the settlement of Zadar 27,767 people (38.85% of the total population) have access to a green space larger than 2 hectares. Since ANGst states that the entire population of the city should have access to green space, it is clear that Zadar does not meet this standard. However, this is also the case with other cities for which this analysis has been made (Kazmierczak et al., 2010), and in the comparison with them, Zadar achieved slightly better results. Comber et al. (2008) followed the same methodology of accessibility analysis for the city of Leicester and concluded that this standard was available only to 10.3% of the population. Barbosa et al. (2007) analysed UGS accessibility for Sheffield and pointed out that only 36.5% of households met the condition of having an accessible green area within 300 m a five minute walk.

4.3 Generating UGS accessibility indicators – *4.3. Generiranje indikatora dostupnosti UZP-a*

The first objective measure taken into account while calculating the UGS accessibility indicator was the average UGS

Šumarski list, 9–10, CXLII (2018), 487–497

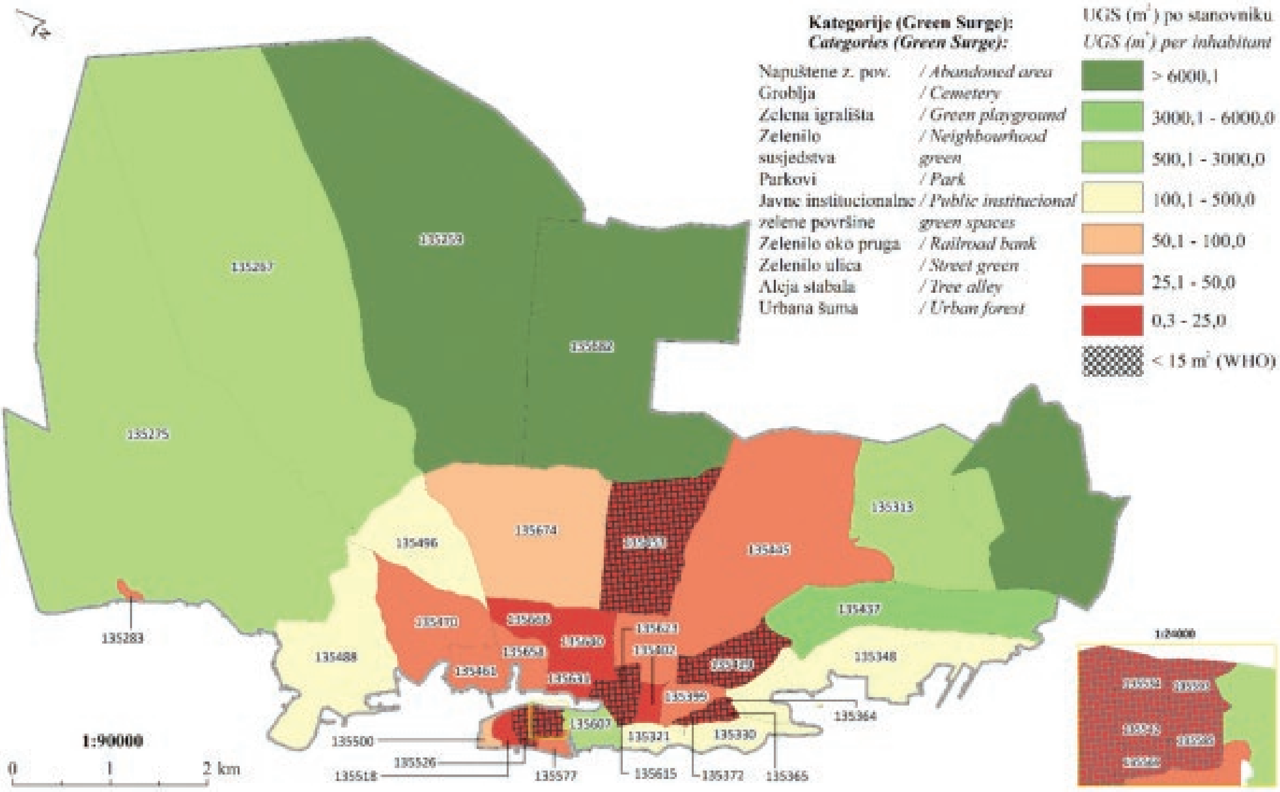

Figure 4. Average surface area (m³) of UGS per capita within statistical circles
Slika 4. Prosječna površina UZP-a po stanovniku unutar statističkih krugova

area (m²) per capita. The optimum value suggested by the WHO* is from 10 to 15 m² of UGS per capita, while the minimum is 9 m² (Karayannis, 2014). In the settlement of Zadar, 13 statistical circles had a smaller than optimum value (15 m²) specified by the WHO. They account for 19,319 inhabitants, or 27.03% of the total city population. Most of these statistical circles are located in the central, older part of the city, which is characterized by dense urban infrastructure. In contrast, some statistical circles recorded values greater than 6,000 m² of green space per capita (Fig. 4).

According to this measure, each inhabitant of Zadar has about 360 m² of green areas. This large value is the result of the administrative border shape, because the NE part consists mostly of abandoned and derelict green and agricultural areas. If we exclude these classes because they do not contribute to the environmental sustainability and identity of the city and along with their poor network connections they cannot be considered as the part of the urban city core, on the each inhabitant of Zadar comes approximately 114 m² of green space. The urban forest of Musapstan is included in this value.

The remaining six measures taken into account while calculating the UGS accessibility indicator referred to the UGS accessibility on the basis of their specific functional levels. According to the parameter of area (m²), a classification of UGS functional levels was made (Van Herzele and Wiedemann, 2003). Access points were determined for each element of the specific functional level and accessibility analysis was performed. Most of the higher UGS functional levels were located outside the inner city (Fig. 5).

It is evident that the highest accessibility values were recorded for the functional levels of the urban forest and residential green. Just under 6% of the population does not have an accessible urban forest within a distance of 5,000 m (Fig. 5). This was anticipated, because this class has the biggest influence zone (5,000 m) and the urban forest of Musapstan is located within the settlement of Zadar. Only 9% of the population does not have access to the functional level of a residential green (Fig. 5). The accessibility of the lowest and highest UGS functional levels are extremely good. The lowest accessibility values were recorded for the functional levels of neighbourhood and city greens, for which 50% of the population have no access. The functional levels of the quarter and district green fared somewhat better results (Fig. 5). The derived six variables of accessibility, for each UGS functional level, were used as objective mea-

* World Health Organization

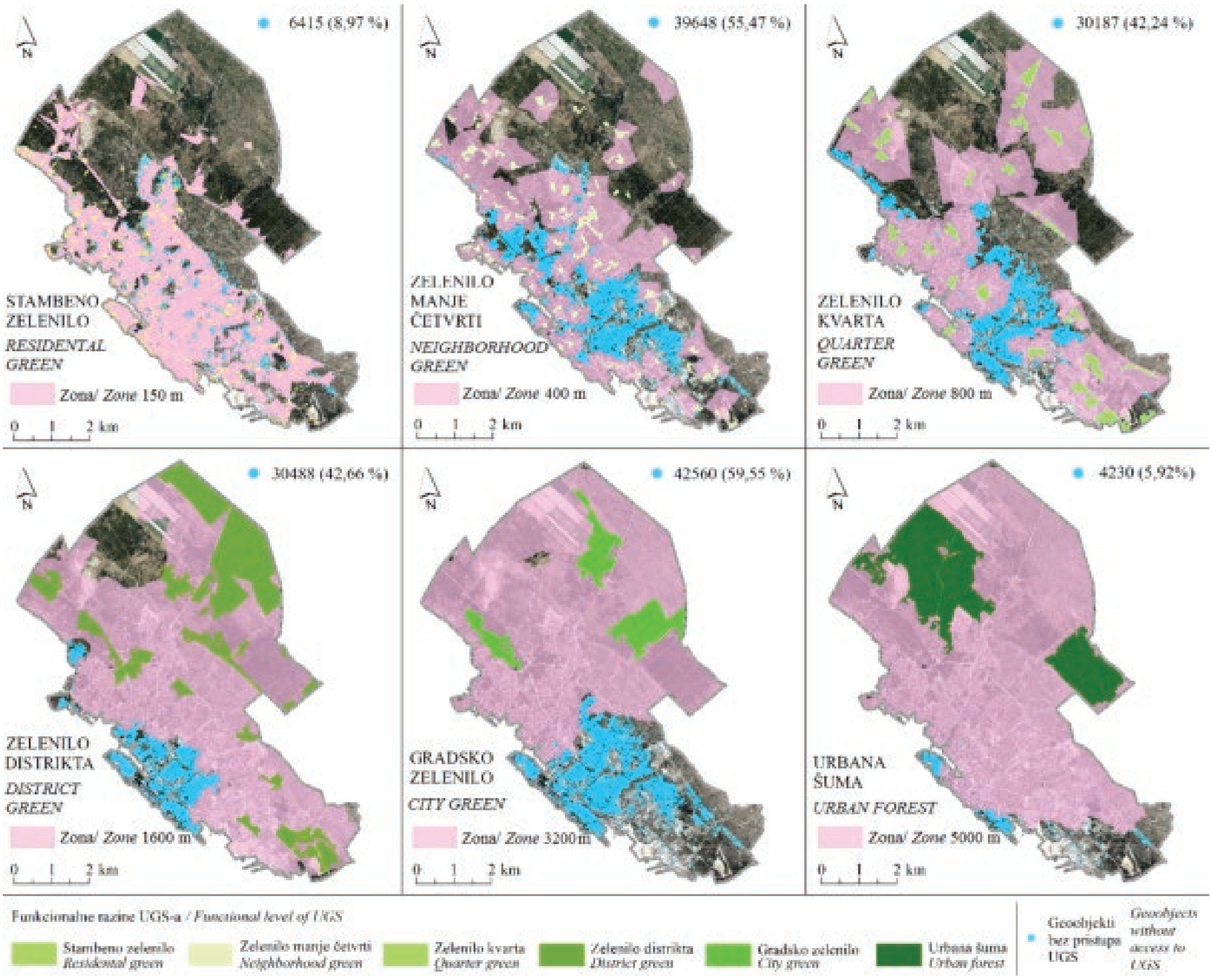

Figure 5 Accessibility zones according to UGS functional levels
Slika 5. Zone dostupnosti prema funkcionalnim razinama UZP-a

sures in the process of UGS accessibility indicator modelling.

Indicators are specific forms of information that indicate the current status, progress and remaining distance to the desired destination (Šiljeg, 2016). They can serve as instruments for making management decisions in the context of monitoring changes of the urban environment quality. In the process of accessibility indicator modelling, an adjustable scale of value (from 1 to 5) was used, because this allowed comparison between the objective created measures. This was due to the impossibility of comparing the different evaluated variables, such as measure stated in *percentage* and measures stated in *square meter per capita*. Thus, each of the seven objective measures was reclassified in the range of values from 1 to 5, based on defined intervals and the natural breaks method used for the variable of UGS per capita. The lowest value (1) indicates the worst results in the context of UGS accessibility, whereas the highest (5) indicates the best. All seven variables had an equal weight coefficient (0.142) while determining the UGS accessibility indicator. The *Analytic Hierarchy Process* (AHP) was not used because it is not precise enough to rank the importance of different variables (functional levels), due to the highly subjective perception of UGS accessibility. Each objective measure within the indicator was multiplied by a constant value of 0.25. This value was used to normalise values from 1-5 to 0-1, so the formula for the accessibility indicator was:

$$I_{ACCES} = 0{,}25 \times \frac{\frac{1}{n}\sum_{i=1}^{n} P_i + \frac{1}{n}\sum_{i=1}^{n} I_{RG} + \frac{1}{n}\sum_{i=1}^{n} I_{NG} + \frac{1}{n}\sum_{i=1}^{n} I_{QG} + \frac{1}{n}\sum_{i=1}^{n} I_{DG} + \frac{1}{n}\sum_{i=1}^{n} I_{CG} + \frac{1}{n}\sum_{i=1}^{n} I_{UF}}{BV} - 0{,}25$$

where:

I_{ACESS} = UGS accessibility indicator

0.25 = constant values in the formula chosen in order to normalize the initial values from 1 to 5 in the range from 0 to 1, so that the single measure of the formula for the normalized value can be read as 0.25 * measure - 0.25

P_i = average UGS area (m^2) per capita

I_{RG}, I_{NG}, I_{QG}, I_{DG}, I_{CG}, I_{UF} = accessibility according UGS functional levels

BV = measure count within the indicator

For all statistical circles, values from 1 to 5 were assigned, indicating the quality of UGS accessibility. It is evident that only one statistical circle (135500) falls within the lowest category (1) of accessibility (Fig. 6). It is important to emphasize that none of the 41 analysed statistical circles had lowest value (1) for all seven objective measures.

Statistical circle 135500 recorded the lowest value of UGS accessibility (1) for six objective measures, with the exception of I_{RG} (residential green). According to I_{RG} measure it was given a classified value of 5. Therefore, in the context of green area accessibility within the inner-city housing environment (a lower functional level of UGS) this statistical circle was characterized by extremely good conditions. This may pose a particular difficulty when comparing results with the city residents' subjective perception of UGS accessibility, because there is a possibility that the population perceives accessibility exclusively at lower UGS functional levels. The mean value of UGS accessibility for the settlement of Zadar is 3.1. Thus, the accessibility derived from the analysis of seven objective measures, according to UGS functional levels for the settlement Zadar, is 3.1 (moderate - *neither satisfied nor dissatisfied)* despite the fact that city of Zadar have 114 m^2 of UGS per capita.

5. DISCUSSION
5. RASPRAVA

An analysis based on subjective indicators complemented the objective indicators, which is why there was a difference in the instruments used and the content covered by objective indicators (Diener and Seligman 2004). As Watson et al. (2010) have emphasized, objective conditions does not need to be simply correlated with subjective ones, and the discrepancy between them can be interpreted in various ways (Ekins and Max-Neef, 1992; Veenhoven et al., 1993; Diener and Suh, 1997; Kahneman et al., 1999). New empirical research has focused on the synergy of objective and subjective indicators, thus simplifying definitions of guidelines for spatial changes and planning.

In this context, the UGS accessibility indicator, generated based on objective measures, was compared with residents' subjective perception regarding UGS accessibility. The results of satisfaction with UGS accessibility for specific statistical circles were presented as the mean of all response's given. The lowest value for a particular statistical circle was 1.5 (135437) and the highest 4.7 (135569). The average value of satisfaction with UGS accessibility for the entire city was 3.4, which did not greatly differs from the value derived on the basis of seven objective measures (3.1). In both cases, UGS accessibility for the city of Zadar was assessed as moderate, i.e. neither satisfactory nor unsatisfactory, in spite of the huge UGS per capita.

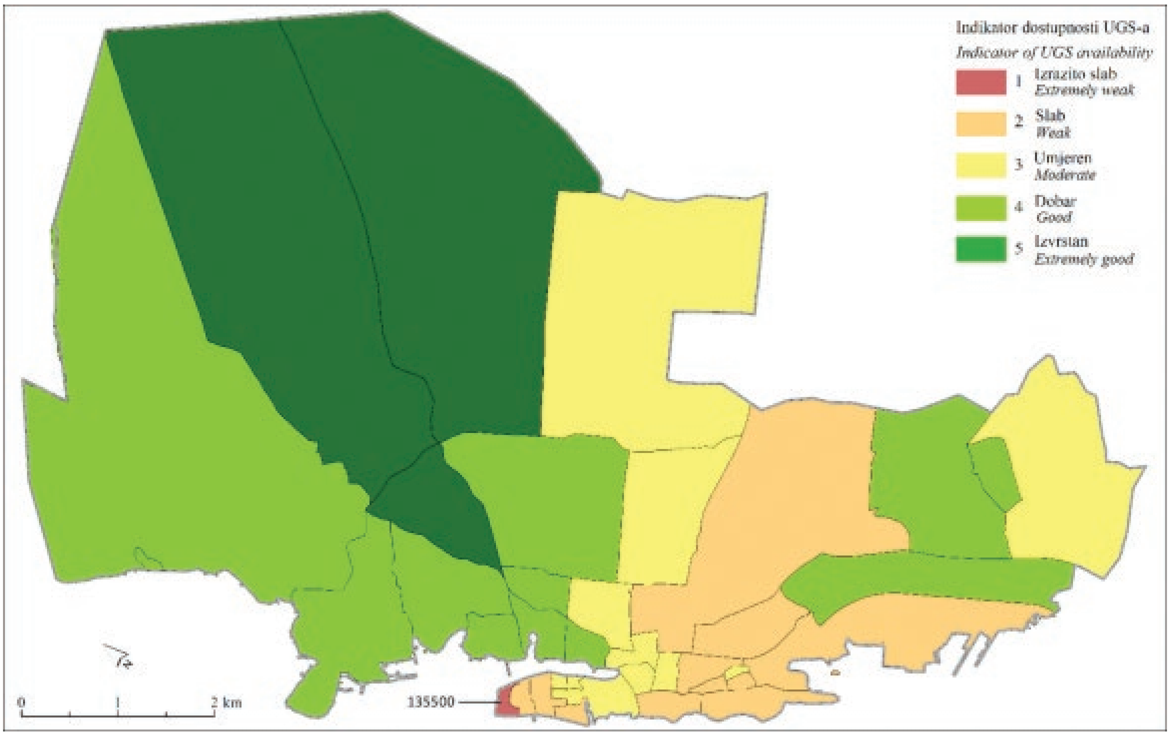

Figure 6. UGS accessibility indicator for Zadar
Slika 6. Indikator dostupnosti UZP-a za naselje Zadar

6. CONCLUSION
6. ZAKLJUČAK

The results showed that, according to the average UGS surface per capita, Zadar achieved above-average results. This is partly due to the specific form of its administrative boundary, and the low urban development of the area. Each resident in the settlement of Zadar has around 114 m² of green space. Although according to the measure of UGS per capita Zadar achieved remarkable results, their distribution and access are unequal. Several variables confirm that. Certain statistical circles have on average just a few m² of UGS per capita, while some recorded values greater than 6,000 m² per capita. Thus, about 27% of the total population lives in statistical circles which have less than 15 m² of green space per capita. Furthermore, according to the ANG standard only 17,846 (24.97%) of residents within a non-linear distance of 300 m have accessible UGS greater than 2 hectares.

The results of this study highlight the fact that UGS importance should not be identified according to size or proportion in the total area of the settlement. UGS importance is best expressed through an evaluation of accessibility to the population. The city of Zadar is a good example where the lack of public transport support and effective connectivity between the UGS and transport networks can easily lead to certain green areas becoming "isolated islands" within the administrative boundaries of the settlement, and as such, people perceive them as inaccessible. Despite the fact that the ratio of built-up and green spaces in the settlement of Zadar is 1:2.3 and that each resident has around 114 m² of green surface, the generated accessibility indicator and residents' subjective measure of satisfaction with UGS accessibility point to discrepancies. According to the UGS accessibility indicator, the mean value for Zadar is 3.1 (moderate) while according to the subjective measure of satisfaction or perception of the population, it is slightly higher, at 3.4 (moderate). The results of this research are in alignment with the claims of Chen and Chang (2015), who pointed out that large areas of green surfaces within a city do not necessarily generate proportionally similar satisfaction with their accessibility.

From the analysis, it can be concluded that UGS accessibility, according to different UGS functional levels through statistical circles in Zadar, has heterogeneous values. The most significant differences were recorded in the statistical circles of the immediate city core (old town) and periphery. Further research should focus on a comparison of these results with other cities in Croatia and quantify differences in terms of UGS accessibility.

7. REFERENCES
LITERATURA

- Barbosa O., Tratalos J. A., Armsworth P. R., Davies R. G., Fuller R. A., Johnson, P., K. J. Gaston, 2007: Who benefits from access to green space? A case study from Sheffield, UK, Landscape and Urban Planning 83 (2):187-195.
- Chen J., Z. Chang, 2015: Rethinking urban green space accessibility: Evaluating and optimizing public transportation system through social network analysis in megacities, Landscape and Urban Planning 143:150-159.
- Chiesura, A., 2004: The role of urban parks for the sustainable city, Landscape and urban planning, 68 (1):129-138.
- Comber, A., Brunsdon, C., E. Green, 2008: Using a GIS-based network analysis to determine urban greenspace accessibility for different ethnic and religious groups, Landscape and Urban Planning 86 (1):103-114.
- DGU, 2017: Digitalna ortofoto karta – listovi naselja Zadar, Državna geodetska uprava, Zagreb. https://geoportal.dgu.hr/. Accessed 30 March 2017.
- Diener, E., E. Suh 1997: Measuring quality of life: Economic, social, and subjective indicators, Social indicators research 40 (1): 189-216.
- Diener, E., M. E. P. Seligman, 2004: Beyond Money: Toward and Economy of Well-being, Psychological Science in the Public Interest 5 (1):1-31.
- Ekins, P., M. Max-Neef, 1992: Real Life Economics, Routledge, London.
- English Nature, 2003: Providing accessible natural greenspaces in towns and cities: a practical guide to assessing the resources and implementing local standards for provision, UK, file:///C:/Users/Ivan/Downloads/r526_part_2[1].pdf, Accessed 25 March 2017.
- Germann-Chiari, C., K. Seeland, 2004: Are urban green spaces optimally distributed to act as places for social integration? Results of a geographical information system (GIS) approach for urban forestry research, Forest Policy and Economics 6 (1): 3-13.
- Grahn, P., U. K. Stigsdotter, 2010: The relation between perceived sensory dimensions of urban green space and stress restoration, Landscape and urban planning 94 (3): 264-275.
- Gunnarsson, B., Knez, I., Hedblom, M., Å. O. Sang, 2017: Effects of biodiversity and environment-related attitude on perception of urban green space, Urban Ecosystems 20 (1): 37-49.
- Gupta, K., Roy, A., Luthra, K., S. Maithani, 2016: GIS based analysis for assessing the accessibility at hierarchical levels of urban green spaces, Urban Forestry & Urban Greening 18: 198-211.
- Irvine, K. N., Warber, S. L., Devine-Wright, P., K. J. Gaston, 2013: Understanding urban green space as a health resource: A qualitative comparison of visit motivation and derived effects among park users in Sheffield, UK, International journal of environmental research and public health 10 (1): 417-442.
- Jennings, V., Larson, L., J. Yun, 2016: Advancing Sustainability through Urban Green Space: Cultural Ecosystem Services, Equity and Social Determinants of Health, International Journal of Environmental Research and Public Health 13 (2): 196.
- Jesdale, B. M., Morello-Frosch, R., L. Cushing, 2013: The racial/ethnic distribution of heat risk-related land cover in re-

lation to residential segregation, Environmental health perspectives 121: 811–817.

- Jim, C. Y., W.Y. Chen, 2006: Perception and attitude of residents toward urban green spaces in Guangzhou (China), Environmental management 38 (3): 338-349.
- Kahneman, D., Diener, E., N. Schwarz, 1999: Well-being: Foundations of hedonic psychology, Russell Sage Foundation, New York.
- Karayannis, G., 2014: Dissecting ISO 37120: Why shady planning is good for smart cities, SmartCitiesCouncil (available at http://smartcitiescouncil.com/article/dissecting-iso-37120-why-shady-planning-good-smart-cities), Accessed at 30 March 2017.
- Karavla, J. 2006: Dendrološke karakteristike zelene potkove grada Zagreba s prijedlogom obnove njezinoga istočnog dijela. *Šumarski list, 130 (1-2)*, 31-40.
- Kazmierczak, A., Armitage, R., P. James, 2010: Urban green spaces: natural and accessible? The case of Greater Manchester, UK. In: Muller et al. (ed), Urban biodiversity and design, Oxford, UK: Blackwell Publishing Ltd, 383-405.
- Koc, C. B., Osmond, P., A. Peters, 2017: Towards a comprehensive green infrastructure typology: a systematic review of approaches, methods and typologies, Urban Ecosystems 20 (1): 15-35.
- Kong, F., Yin, H., Nakagoshi, N., Y. Zong, 2010: Urban green space network development for biodiversity conservation: Identification based on graph theory and gravity modelling, Landscape and urban planning 95 (1): 16-27.
- Kuta, A. A., Odumosu, J. O., Ajayi, O. G., Zitta, N., Samail-Ija, H. A., E.A. Adesina, 2014: Using a GIS-Based Network Analysis to Determine Urban Greenspace Accessibility for Different Socio-Economic Groups, Specifically Related to Deprivation in Leicester, UK, Civil and Environmental Research 6 (9): 12-20.
- Litt, J. S., Soobader, M. J., Turbin, M. S., Hale, J. W., Buchenau, M., J. A. Marshall, 2011: The influence of social involvement, neighborhood aesthetics, and community garden participation on fruit and vegetable consumption, American journal of public health 101 (8): 1466-1473.
- Luo, W., F. Wang, 2003: Measures of spatial accessibility to health care in a GIS environment: synthesis and a case study in the Chicago region, Environment and Planning B: Planning and Design 30 (6): 865-884.
- Mak, C., Scholz, M., P. James, 2017: Sustainable drainage system site assessment method using urban ecosystem services, Urban Ecosystems 20 (2): 293-307.
- Oh, K., S. Jeong, 2007: Assessing the spatial distribution of urban parks using GIS, Landscape and Urban planning. 82 (1): 25-32.
- Qureshi, S., Breuste, J. H., S. J. Lindley, 2010: Green space functionality along an urban gradient in Karachi, Pakistan: a socio-ecological study, Human Ecology 38 (2): 283-294.
- Sandström, U. G. 2002: Green infrastructure planning in urban Sweden, Planning Practice and Research 17 (4): 373-385.
- Sandström, U. G., Angelstam, P., G. Mikusiński, 2006: Ecological diversity of birds in relation to the structure of urban green space, Landscape and urban planning 77 (1): 39-53.
- So, S. W. 2016: Urban Green Space Accessibility and Environmental Justice: A GIS-Based Analysis in the City of Phoenix, Arizona, Doctoral dissertation, University of Southern California, Los Angeles
- Sotoudehnia, F., L. Comber, 2011: Measuring perceived accessibility to urban green space: an integration of gis and participatory mapm, In: 14th AGILE Conference on Geographic Information: Advancing Geoinformation Science for a Changing World (available at: https://agileonline.org/conference_paper/cds/agile_2011/contents/pdf/shortpapers/sp_148.pdf)
- Šiljeg, S. 2016: Evaluation of quality of housing in Zadar, Doctoral dissertation, University of Zagreb, Zagreb.
- Teodolit, 2017. Velebitska 8 A, 23000 Zadar
- USGS, 2017. The United States Geological Survey (https://lta.cr.usgs.gov/L8), Accessed 25 March 2017.
- Van den Berg, A. E., Maas, J., Verheij, R. A., P. P. Groenewegen, 2010: Green space as a buffer between stressful life events and health, Social science & medicine 70 (8): 1203-1210.
- Van Herzele, A., T. Wiedemann, 2003: A monitoring tool for the provision of accessible and attractive urban green spaces, Landscape and urban planning 63 (2): 109-126.
- Veenhoven, R., Ehrhardt, J., Ho, M. S. D., A. de Vries, 1993: Happiness in nations: Subjective appreciation of life in 56 nations 1946–1992, Erasmus University Rotterdam.
- Watson, D., Pichler, F., C. Wallace, 2010: Second European Quality of Life Survey: Subjective Well-being in Europe, Office for Official Publications of the European Communities, Luxembourg.
- Wolch, J. R., Byrne, J., J. P. Newell, 2014: Urban green space, public health, and environmental justice: The challenge of making cities 'just green enough', Landscape and Urban Planning 125: 234-244.
- Zadar Nova, 2016: Urban Green Belts (UGB) project WPT 1 Activity 1.1, Common methodology for local assessment and analysis of urban green space (UGS) (http://www.zadra.hr/wp-content/uploads/2016/10/Metodologija.pdf), Accessed 25 March 2017.

SAŽETAK

Dostupnost urbanih zelenih površina (UZP) sastavni je element zadovoljavajuće kvalitete života. Zbog nagle urbanizacije proučavanje zelenih površina postaje jedan od ključnih elemenata urbanističkog planiranja. Funkcionalna mreža prometnog sustava i optimalan prostorni raspored UZP-a preduvjeti su za održavanje ekološke ravnoteže urbanog krajolika. Analiza dostupnosti UZP-a u naselju Zadar izvršena je u sklopu projekta Urban Green Belts Project (UGB). Analizi je prethodila izrada prostorno-orijentirane baze UZP-a. Podaci su prikupljeni metodom nadzirane klasifikacije multispektralnih LANDSAT snimaka i metodom ručne vektorizacije DOF snimaka. U prvoj fazi istraživanja izvršena je analiza dostupnosti

UZP-a prema ANG standardu. Indikator dostupnosti generiran je na temelju sedam objektivnih mjera koji uključuju površinu UZP-a po stanovniku te dostupnost šest funkcionalnih razina UZP-a. Izvedeni indikator dostupnosti uspoređen je sa subjektivnim mjerama koje su izvedene anketnim ispitivanjem 718 ispitanika unutar 41 statističkog kruga. Prikupljeni podaci reflektiraju individualnu procjenu te zadovoljstvo dostupnošću UZP-om. Ovo istraživanje istaknulo je važnost korištenja objektivnih i subjektivnih mjera u procesu razumijevanja dostupnosti UZP-a. Rezultati su pokazali da prilikom vrednovanja dostupnosti stanovnici naglasak stavljaju na uže stambeno okruženje, zanemarujući time više funkcionalne razine UZP-a. Nadalje, velike količine UZP-a unutar grada (114 m² po stanovniku) ne moraju generirati slično zadovoljstvo njihovom dostupnošću. Izlazni rezultati mogu služiti kao smjernice za daljnji razvoj grada u kontekstu planiranja funkcionalne mreže UZP-a.

KLJUČNE RIJEČI: urbane zelene površine (UZP), indikator dostupnosti, subjektivne i objektivne mjere, Zadar.