

Subjective evaluations of urban parks and objective spatial indices

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Abstract

Perceptions of the spatially describable characteristics of an urban environment hardly ever match the objective environmental indicators. Including city dwellers' subjective evaluations of urban spaces would considerably foster decision making practices. This article explains a methodology implemented by the authors to reveal the relation of subjective spatiality and objective characteristics of urban parks in the city of Szeged, Hungary. A questionnaire survey was conducted for urban green areas to reveal urban dwellers' perception of the respective parks. Objective spatial indicators describing environmental settings of the parks were then calculated using GIS techniques. While both the subjective evaluations and spatial indices provide new insights into the perceptions of urban green areas, statistical analyses showed minor correlations between subjective evaluations and objective spatial properties of the investigated urban green spaces.

Keywords: Subjective evaluations; Objective spatial indices; Urban green areas; GIS; Statistics

1 Introduction

Cities operate as multidimensional conglomerates of closely coupled societal, economical, ecological, and infrastructural systems in which dwellers are largely detached from the natural environment. In this urban construct, the Quality of Life (QoL) of citizens should be central to decision making and planning processes. To facilitate these practices, local governments and scientific and civil organisations frequently assess the quality of urban life. These projects repeatedly generate indicators based on the point of view of the surveyed people. This point of view is rather complex and reflects individually dependent, subjective opinions and perceptions.

Spatial data is often available to city councils to provide input for maps of public services, and, more importantly, foster policy decision making and urban planning [5]. In the last decades, objective indicators have frequently been generated to facilitate the mapping and understanding of the ambient urban environment for the sake of more informed decision making [2, 8, 17].

Green areas in urban constructs have major direct and indirect contributions to the QoL. Beyond being important air purifiers [6, 15] and urban microclimate regulators [4, 13], they positively affect the physical and mental health of the population [1, 10], serve as a space for recreation and social cohesion [9, 16], and provide shelter and a habitat for biodiversity [7].

Although subjective evaluations of the urban environment have the potential to provide a substantial addition to the objective indicators, they have seldom been studied in relation to one another [12]. The knowledge gap is further enhanced when properties of the "human perception of space" (= place) are researched for the sake of improving the understanding of the urban environment [11].

Geographic information systems have the potential to bridge the gap between disciplines (e.g. environmental psychology, statistics, etc.) in order to understand the human space perception.

Therefore, in this study, GIS invokes the help of statistics in order to describe a multidisciplinary methodology that relates subjective evaluations of urban green areas to measured, objective, spatial indices which characterise the studied urban parks.

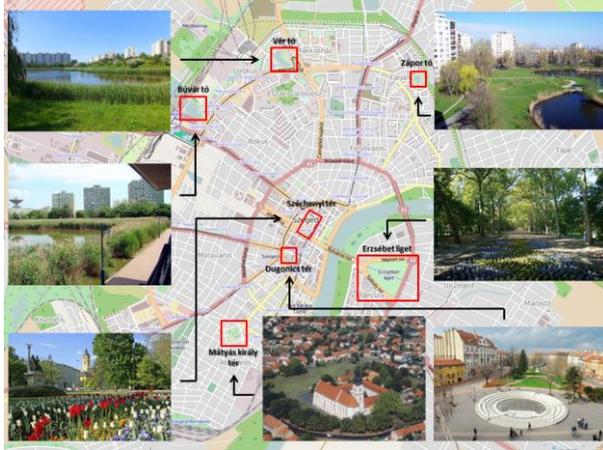
2 Method

2.1 Study areas and data

The study was conducted in relation to seven urban parks in the City of Szeged, in the South-East of Hungary. Szeged, with a population of 160000 people, offers a variety of green spaces to enhance the QoL of citizens and visitors. The research was initially carried out in relation to seven parks – later reduced to five parks – representing three different type of public green spaces (Figure 1). Erzsébet liget (ER) is a 21 ha area covered mostly with lawn and trees in the vicinity of the city centre. Dugonics tér (DU) is a newly refurbished square in the city centre with a small proportion of green area. The Széchenyi tér (SZ) is the main square of Szeged and is kept exceptionally well maintained. Vér tó (VE) is situated at the edge of the city surrounded by 5-10 storey residential blocks. Zápor tó (ZA) is similar to VE in terms of being surrounded by residential housing and attracts similar social groups. Búvár tó (BU) is again similar to the ZA and VE with the exception that there is a shopping mall at the edge of this park. Mátyás tér (MA) is out of the city centre in a densely

built up area offering green space mainly for citizens of nearby neighbourhoods.

Figure 1: The studied parks



Source: OpenStreetMap; Edit Lapatinszki; <http://www.panoramio.com/photo/20151532>; http://www.u-szeged.hu/site/upload/2013/03/Dugonics_t_r_SZTE_ablakb_1_4.jpg; <http://users.atw.hu/koalexa/kepek/ter.jpg>; <http://mw2.google.com/mw-panoramio/photos/medium/14695253.jpg>; http://szepvilagunk.weebly.com/uploads/2/6/0/1/26017485/4706697_orig.jpg; http://www.sk-szeged.hu/statikus_html/digitalis/szrt/galeria/1_alsovarosi_templom.jpg.

A questionnaire survey provided the subjective data input for the research. A questionnaire was designed and three survey campaigns (April, May, and July of 2014) were conducted applying the semi-random sampling method in the seven studied parks. During this period, an online survey was also operated with the same questions in regard to the aforementioned parks. The questionnaire aimed to explore the subjective evaluations of the park visitors on objective, spatially describable properties of the studied green spaces. To comply with this goal, the main topics of the survey were the personal judgement of the area, the greenness of the park, the accessibility and, finally, the functions of the area.

The objective data was a set of raster and vector layers.

A newly acquired (30th August 2014, 12:15) multispectral Pléiades satellite imagery was used to calculate the Normalized Difference Vegetation Index (NDVI).

The vector layers used were:

- A building height layer [14];
- A Cadastral layer;
- Area of the studied parks;
- Water surfaces in the studied parks;
- Vegetated surfaces within the parks;

2.2 GIS analysis

Answers of the questionnaire survey campaigns were recorded in tabular format and inputted into ArcGIS 10.1, in which the GIS analysis was performed. The objective spatial indices described below were calculated for each park based on the

available vector data and merged to the records of surveyed persons in relation to the parks they answered for.

- NDVI for the parks;
- Percentage of vegetated surfaces;
- Percentage of water surfaces;
- Number of building units in a 50 m buffer zone around the parks;
- Percentage of the area of buildings within the 50 m buffer zone around the parks;
- Building height within the 50 m buffer zones around the parks

Mean and standard deviation statistics of the above-mentioned objective attributes were calculated for each park. The results were joined to the table containing the subjective data. The resulting attribute table then contained the subjective evaluations and objective spatial indicators of the respective parks for each and every answer. This table served as the input data for the statistical analysis.

2.3 Statistical analysis

The statistical analysis was performed using the software SPSS 21. Nominal type data were transformed to dichotomous variables. (1) First, an explorative data analysis was performed to check the data for possible violations of statistical preconditions and outliers. (2) Then, a Principal component analysis was applied to merge similar questionnaire items into "concept dimensions" and thereby reducing the number of variables required for the subsequent regression analyses. During this process, similar questions of the questionnaire were gathered around main topics (principal components). (3) The consistency of the thus identified data dimensions were assessed with a reliability analysis (factor analysis) using the Bartlett's test ($\chi^2_{(136, N=261)} = 1170.03, p < .01$). The analysis resulted in a three-factor solution where the explained variance was 49.01%. The identified subjective scores were:

- "Impression of green, healthy and recreational environment" (24.05%; Cronbach's $\alpha = .83$),
- "Impression of the state of the park" (13.04%; Cronbach's $\alpha = .71$),
- "Assessment of accessibility of the park by private or public transport" (11.92%; Cronbach's $\alpha = .65$).

The procedure of using factor and item analysis as described above is often used in psychological science to create new psychometrical or personality tests. The factor analysis identifies possible highly intercorrelating "item-bundles" which are, at the same time, clearly delineable from other "item-bundles". These "bundles" are called "components", "dimensions", or "factors" (the term "factor" has a different meaning in other statistical methods such as e.g. ANOVA). The item analysis, on the other hand, verifies whether the intercorrelation of each "item-bundle" is high enough to summarize these into a single variable or not.

In this particular case, these methods were used to reduce the number of variables used in the data analysis without losing too much essential information of the questionnaire items for statistical purposes. By doing this, the statistical results are more clearly arranged and comprehensible

compared to using every single questionnaire item for the analysis.

(4) At BU and MA the majority of interviewees were women, which created a gender bias that was identified and later eliminated using a chi-square test. After identifying an imbalance in the gender-distribution between the parks BU and MA and the rest of the parks, the data records of BU and MA were eliminated from the survey sample to prevent a possible distortion of subsequent regression results (e.g. women tend to rate questionnaire items more mildly compared to men). (5) The three identified subjective assessment dimensions, without using data from BU and MA, were then used as dependent variables to execute a multiple regression analysis to identify predictors for these three subjective assessment dimensions. A stepwise regression model was used and a bootstrapping was applied for robust regression estimates and VIF checking for possible multicollinearity. Each subjective assessment dimension was used as a dependent ("criterion") variable (DV) in "its own analysis", objective and questionnaire data were used as independent ("predictor") variables (IVs) in each regression model, resulting in three multiple regressions performed:

- DV "Impression of green, healthy and recreational environment": $R^2=.24$, $F_{(2,213)}=35.39$, $p < .01$. (Final) predictors: "Percentage of vegetation" ($\beta=.48$, $p < .01$) and "How far is the area from your home?" ($\beta=-.12$, $p < .05$).
- DV: "Impression of the state of the park": $R^2=.26$, $F_{(2,219)}=40.56$, $p < .01$. (Final) predictors: "Area of buildings/Area of 50 m buffer zone" ($\beta=.43$, $p < .01$) and "Number of (subjective) disturbance factors" ($\beta= -.25$, $p < .01$).
- DV: "Assessment of accessibility of the park by private or public transport": $R^2=.06$, $F_{(3,223)}=6.14$, $p < .01$. (Final) predictors: "Gender" ($\beta= -.18$, $p < .01$), "Standard deviation of building height in 50 m buffer zone" ($\beta = -.15$, $p < .05$) and "Number of buildings within 50 m buffer zone" ($\beta = .13$, $p < .05$).

3 Results and discussion

Implementing parks for health and recreational purposes in the urban environment has a long tradition in city planning history. In the 19th century, functions of parks changed from a form of "landscape art", to "natural pleasure grounds" and "places for public group activities". Since parks were sometimes also sites of more negative impressions at the end of the 20th century, they are now experiencing a renaissance through modern city planning efforts [3]. Considering the complexity of the "park" concept, the results of the actual study should be discussed here. This section explains the meaning of the three identified dependent variables.

The interpretation of the correlation of "Impression of green, healthy and recreational environment" with the "Percentage of vegetation" and "How far is the area from your home?" is attributable to the greener parks in the vicinity of which most visitors lived.

The positive (mood and health) effect of the perception of the natural environment including vegetation, animals, or generally the natural landscapes, is often discussed and

examined in (environmental, biological and health) psychology. The theoretical range spans from evolutionary hypotheses to findings of new empirical studies. Therefore it is not surprising, that the "Percentage of vegetation" proves to be a solid predictor for the DV "Impression of green, healthy and recreational environment". The small effect of the proximity to the park and its influence on the subjective perception of the "green, healthy and recreational" characteristics is not absolutely clear and without ambiguity. Despite the possibility of numerous explanations for this empirical phenomenon, the authors don't want to "slither into speculations". So this result has to be investigated by further studies.

"Impression of the state of the park" presented a correlation with the "Percentage of the area of buildings within the 50 m buffer zone around the parks" and the "Number of (subjective) disturbance factors". The surroundings of the studied areas in the city center are very densely built up and these parks are those where participants perceived the least disturbance factors.

"Impression of the state of the park" is, in other words, determined, or at least influenced, by the surrounding city scene (e.g. architectural characteristics of the buildings nearby) and, of course, also by the number of subjective disturbing perceptions of the interviewee (e.g. noise, uncared-for lawn, mosquitoes).

The "Assessment of accessibility of the park by private or public transport" was found to be correlated with "Gender", "Standard deviation of building height in 50 m buffer zone" and "Number of buildings within 50 m buffer zone".

"Assessment of accessibility of the park by private or public transport" seems to be influenced by the urban city characteristics of Szeged. Areas where the buildings tend to be higher and have lower variation in their height might have a slightly better transportation infrastructure (but this statement should be examined by future research). On the other hand, the tendency of women to review questionnaire items more mildly compared to men is a well-known social psychological effect.

Even though the identified correlations were not strong enough to indicate a robust relationship between the reported subjective opinions and objective spatial indices, the mutual application of geographic information systems and statistical methods is promising to research the fuzzy relation of observed space and objective environmental indicators. As this research field is new and scholars are recently pioneering study methods, the area needs further attention from future studies.

In the particular case of this study, parks are not mono-featured infrastructures but have multiple functions determined by individual subjective needs and prospects. It will not be possible to build the perfect park for everybody, comparable to the impossibility of cooking a dinner which tastes the same for all. However, using professional evaluations, it could be possible to identify necessary commonalities, which every park should exhibit. Furthermore, it should also be possible to determine area-specific characteristics that are necessary for, or desired by, a larger community beyond the local residents of a place. This mixture of top-down-planning and bottom-up-evaluation processes

could be a new and promising way of modern participatory urban planning.

4 Conclusion

For both approaches, namely the subjective perceptions and the objective indicators, important findings emerged from this work. Particularly the described statistical analysis proved to be a successful complementation to GIS processes aiming to explore the relation between the subjective perception of the physical environment and objective indicators. Nevertheless, a rigid statistical analysis did not yield significant correlations between subjective evaluations of the researched green spaces and the applied objective indicators. The methodology used in this research is intended to be exploratory in nature, revealing patterns within complex spatial and multidimensional datasets. Future research will utilize the results further in additional confirmatory statistical approaches to test the hypothesized relationships and to identify causal relationships - in this case why there is no significant correlation. The authors are convinced that further analysis will allow us to examine the fuzzy relation of subjective and objective indicators of urban environments. This is needed by planning authorities and neighborhood initiatives aimed at enhancing QoL.

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