



Evaluating the importance of urban green spaces: a spatial analysis of citizens' perceptions in Thessaloniki

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Abstract

In Greek cities, urban green spaces are scarce and well below acceptable standards. However, policy makers and planners are not prioritizing long-term planning strategies for urban green and do not attempt to engage citizens in relevant decision-making and urban planning processes. In this context, a web-based public survey was conducted in the city of Thessaloniki (Greece) during the COVID-19 pandemic, aiming to identify citizens' attitudes, satisfaction levels, actual behaviour and future expectations about urban green spaces (UGS). It also aimed to measure the effect of COVID-19 (mobility) restrictions on UGS visitation. All these issues were explored through a spatial lens, by developing measurable and mappable results suitable for future urban planning decisions. According to these results, citizens tend to report a very low satisfaction level about the current state of UGS (in terms of their adequacy and quality), and they tend to travel a great distance to reach an urban park (about 2 km on average). Moreover, the results indicate that spatial differences are very significant in terms of UGS availability and accessibility. Another important outcome of this study is that, unlike in other cities, the frequency of visiting green spaces in Thessaloniki did not increase during the pandemic. On the contrary, a slight downward trend was observed, maybe due to the combined effect of restriction measures and the lack of proximity/availability of UGS to local population groups. The maps produced in this study may thus facilitate well-informed planning decisions related to the development of new green projects.

Keywords Public green spaces · Urban greening · Spatial analysis · Resilient cities · Citizen's attitude and expectations

Introduction

Urban green spaces (UGS) are usually seen as spaces that are directly used for active or passive recreation or are indirectly used by virtue of their positive influence on the urban environment, are accessible to citizens, and serve their diverse needs (Grunewald et al. 2017). Hence, green spaces can provide significant social, economic, environmental, and health benefits to city residents, and contribute to the quality of life in the urban setting (Tzoulas et al. 2007; Ambrey et al. 2014). Some of these benefits are: (1) reduction of

respiratory and cardiovascular illnesses, (2) increase of shade/thermal comfort and reduction of heat-related illnesses, (3) provision of recreational spaces and promotion of outdoor recreational activities, (4) reduction of anxiety and mental fatigue, (5) aesthetic appreciation and increased inspiration, (6) increase property values, (7) enhancement of social interactions, communication skills and social/neighborhood ties (Lee and Maheswaran 2011; Pappas et al. 2021; Semeraro et al. 2021). For this reason, several recent movements in urbanism, such as ecological urbanism, ecological landscape urbanism and landscape urbanism, emphasize that it is vital for the quality of life of cities to prioritize nature and ecological considerations. UGS can play a very important role in this direction (Mostafavi and Doherty 2016; Steiner 2011; Waldheim 2016). Taking into account the multiple ecosystem services that UGS may supply to the urban environment (e.g. stormwater runoff, reducing the heat island effect, supporting urban biodiversity, improving air quality, carbon sequestration, etc.), the European Commission highlighted the importance of transforming the

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traditional concept of isolated UGS (parks and gardens) into a comprehensive vision of green infrastructure (EC 2013), which seeks to balance “people, planet and profit” (Borgström and Kistenkas 2014). This vision has been additionally reinforced in the New Green Deal (EC 2019).

Since March 2020, due to the COVID-19 pandemic, a huge change in everyday life has taken place in cities, with unprecedented restrictions on their inhabitants in terms of both individual mobility and recreation and leisure options. Restrictions on various leisure facilities (such as restaurants, shopping malls and recreational places), cancellations of social activities and the need for self-quarantine and social distancing have made parks and green spaces very popular and vital for public (physical and mental) health, and they provide social benefits (Geng et al. 2021; Ritchie et al. 2020). Access to natural settings such as UGS has emerged as a likely component of the resilience to the pandemic (Venter et al. 2020). Hence, it seems that the pandemic has acted as a catalyst for the re-evaluation of the urban environment by city dwellers, and consequently for a re-assessment of the value of public green spaces.

At the same time, all over the world, scientists, municipal officers and decision makers are working together intensively in order to create new green spaces or to enhance the existing UGS in the context of urban resilience to climate change. Besides, as emphasized in the resilience strategies of many cities, the strengthening of urban resilience is inextricably linked to the (quantitative and qualitative) upgrading of UGS, while green infrastructure is considered one of the best planning tools for adaptation to climate change (Yianakou and Salata 2017).

In Greece, UGS are scarce and well below the acceptable standards (9 m² of green space per city dweller), as suggested by the World Health Organization (WHO, 2010). This is also the case for the city of Thessaloniki, a typical compact city facing a lack of open and green space, as the share of green area per person is only 2.6 m². Moreover, the size of an UGS in Thessaloniki is usually quite small, as only 30% of them are larger than 500 m² (Latinopoulos et al. 2016). This shortage and fragmentation of green spaces has significant environmental and health impacts (e.g. its impact on air quality) and lowers resilience to climate change (e.g. urban heat island phenomena). Despite all the obvious advantages of UGS, the development of a long-term planning strategy for urban green infrastructure has never been a key priority for local (city and regional) policy makers. A reason for this is that local policy makers usually consider only the aesthetic services (values) of UGS, disregarding their critical ecological, health and social functions (Latinopoulos et al. 2016). Therefore, it was not surprising that, during the pandemic, the UGS of Thessaloniki received little attention and remained subject to considerable development pressures, as city planners and local authorities remained reluctant to

articulate the environmental, social, health and economic value of these areas.

In light of the above, it is now particularly necessary to integrate citizens' concerns, preferences and perceptions into the decision-making and planning processes regarding urban green infrastructure. Human perceptions regarding the urban environment are subjective and differ from person to person (Langemeyer et al. 2015). Therefore, the benefits derived from UGS and their objective properties should be interpreted individually (Kothencz and Blaschke 2017). A number of studies have focused on investigating public attitudes and perceived benefits related to UGS (e.g. Baur et al. 2013; Jim and Chen 2006). Some recent studies particularly examined the relationship between green spaces and well-being during the pandemic (Ugolini et al. 2020; Xie et al. 2020). Citizens' attitudes towards UGS have been measured largely through structured questionnaire surveys (Balram and Dragičević 2005), but there are also other techniques/methods available to understand citizens/visitors' attitudes towards UGS (mainly related to recreational capacity and aesthetic appreciation), such as the use of crowd-sourcing data that utilize geotagged UGS (Kothencz et al. 2017).

On the other hand, GIS-based methods tend to examine some objective indicators/attributes of UGS (e.g. NDVI index, the distribution of urban vegetation in a city and the residents' access to public green spaces) or attributes that may be used as decision factors for new urban green development (e.g. temperature, the urban heat island effect, population density, accessibility to green space, air quality, etc.) (Landry and Chakraborty 2009; McConnachie and Shackleton 2010; Nesbitt et al. 2019). Furthermore, GIS-based tools have also been applied in order to evaluate accessibility to—and the quality of—UGS with the aim of supporting decision making and planning at the urban scale (Stessens et al. 2017). Studies that explore the correlation between perceived and objective attributes are scarce, but they usually reveal that subjective evaluations are very important, as they are likely to differ from objective data. Interestingly, such a study was recently conducted in the city of Thessaloniki to examine how the built environment characteristics, and particularly the proximity to UGS (e.g. large parks) relate to (self-reported) health and well-being before and during COVID-19 (Mouratidis and Yiannakou 2022). In another relevant study, Bertram and Rehdanz (2015) combined spatially explicit survey data with spatially disaggregated GIS data on urban green space in order to explore the effect of UGS to the self-reported well-being (life satisfaction) of the residents of Berlin. Another method which shows much promise in incorporating socio-spatial information in strategic green space planning is Public Participation Geographic Information Systems (PPGIS) (Rall et al. 2019). An interesting review of studies applying PPGIS to urban systems, and particularly to UGS is presented by Ives et al. (2017).

The present study aims to couple the subjective evaluations/preferences of citizens with a geographical information system (GIS) in order to develop a handy spatial analysis tool for UGS. In this context, a geo-questionnaire survey (i.e. a questionnaire linked with interactive maps) was conducted to analyse and assess urban residents' access to public UGS, to measure citizens' attitudes towards UGS, as well as to investigate the subjective evaluations of visitors to UGS. This method can be considered as a top-down PPGIS and the feedback of this analysis can be interpreted in order to support future urban green infrastructure planning in the city of Thessaloniki. The findings of the present study may also apply to cities in similar climatic conditions (e.g. in many Mediterranean cities), as well as, to cities that face similar challenges (i.e. the challenge of increasing green infrastructure in order to improve the living standards for their residents and to underpin nature-based solutions for urban resilience to climate change).

Materials and methods

A web-based survey with 25 questions was conducted among residents of the Thessaloniki urban area. The questionnaire was designed using LimeSurvey® software as a survey tool, an open-source online survey application (web-server-based software) written in PHP (Hypertext Preprocessor) and distributed under the GNU General Public License (LimeSurvey GmbH, Hamburg, Germany, <http://www.limesurvey.org>). The survey was optimized for both computers and mobile devices, published online (hosted on Aristotle University's server), and distributed through emails and social media platforms from 3 February 2021 to 3 March 2021. A total of 1824 clicks were received, generating a final sample of 1049 survey responses.

The questionnaire consisted of four parts. The first part surveyed respondents' general attitudes and beliefs about the current situation regarding green spaces. Respondents were also asked to mark on a map (through an interactive user interface) their home location as well as the location of the green space/park that they spend the most time in (i.e. the most frequently visited green space). For this purpose, a broader definition of (public) green areas was adopted, following the objective assessment of respondents (i.e. based on the greenery and open spaces available to users for recreational activities). The two marked points for each respondent were used to estimate the distance the citizen travels from their home (supply point) to their preferred green space (demand point).¹ It should be noted that the

distance of UGS from home is usually considered the most important precondition for the use/selection of green spaces (e.g. Grahn 1994). Another important factor that affects a citizen's choice of green space is the functional level of the green space, i.e. the range of functions and activities that each UGS is able to support. Therefore, a decisive criterion in park selection by citizens is the size of the UGS, which is likely to determine the range of functions or activities that the UGS is able to support. Hence, residents may prefer to travel longer distances than the distance to their nearest UGS in order to reach a larger park that offers more amenities, more potential uses and therefore more benefits (Stessens et al. 2017). In this context, all the UGS selected by the respondents were identified through Urban Atlas data sourced from Copernicus (<https://land.copernicus.eu/local/urban-atlas>, accessed on 9 November 2021), and their areas were calculated using the "measure area" function of the QGIS 3.18 software (QGIS, Zurich, Switzerland, <https://www.qgis.org/en/site/>).

In the second part of the questionnaire, the citizens of Thessaloniki were asked about (a) their motivations for selecting particular parks/urban green spaces, (b) the special features of and problems with those areas, (c) the means of transport used to reach them, (d) the time they stay on-site, as well as (e) the frequency that they visited urban green spaces prior to the pandemic and during the pandemic (excluding from the analysis the period during which there were very strict lockdown restrictions).

The third part of the questionnaire contained questions about the citizens' "vision" with regard to the future planning and management of UGS in Thessaloniki, including the need for new urban green infrastructure. In this part, participants were asked to vote for a future large-scale redevelopment program for the city of Thessaloniki concerning the area where the Thessaloniki International Fair (TIF) is currently situated. Two alternative scenarios were provided: (a) to redesign the site based on the current development plan, in which the fair remains on-site and new commercial and tourist-oriented facilities (providing new green spaces that will cover approximately 30% of the site area) are established, or (b) to transform the whole site into a large metropolitan park, thus creating a single (autonomous) open-space area with a safe and relaxed urban environment for cultural and recreational activities. In the second scenario, the TIF will be relocated to new premises outside the city centre.

The final part of the questionnaire consisted of several questions regarding the socio-economic and household characteristics of the respondents, including sex, age, education level, occupation, household members, number of children under age 18, income, etc. The results are reported in the following section according to the grouping of questions presented above.

¹ The margin of error for this procedure was considered to be within acceptable limits of accuracy.

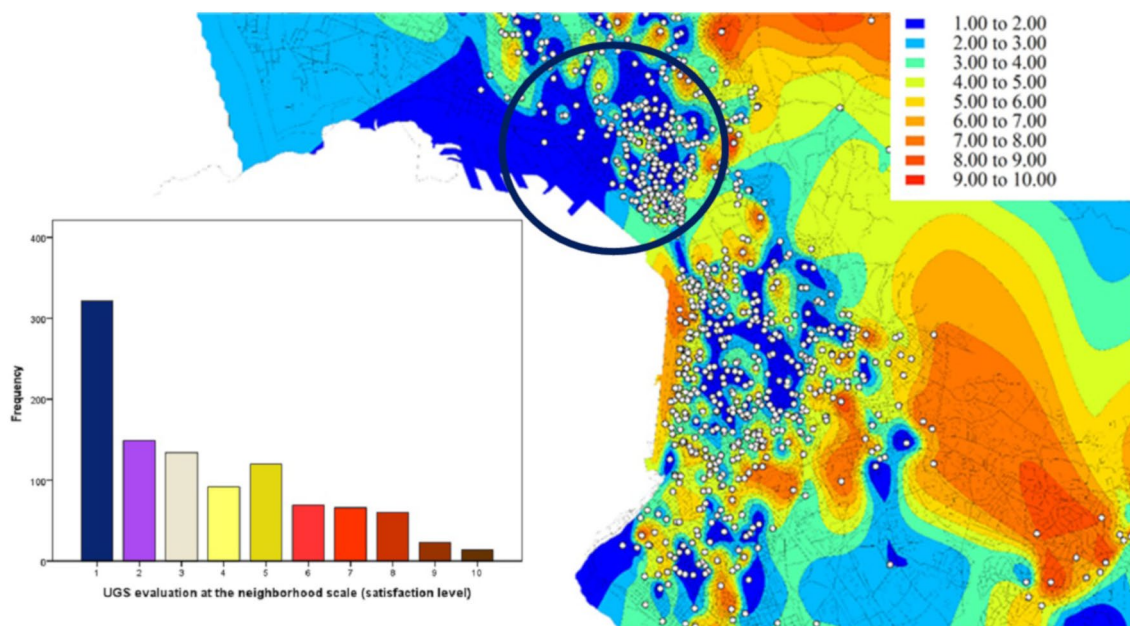


Fig. 1 Spatial distributions of participant location (residence) and satisfaction level concerning the UGS in their neighbourhood (based on spatial interpolation)



Fig. 2 Heat map of UGS attractiveness based on visit count analysis

Results and discussion

The sample in this study consisted of 1049 urban residents of Thessaloniki. The spatial distribution of participant location is given in Fig. 1, which shows a quite homogeneous distribution that covers the entire urban area. About 44% of the participants were male and 56% were female. Their average age was about 42 years old (median = 43). The average number of household members was 2.8 and the average household income was approximately 1600€/month.

Participants were first asked to rank on a 1–10 Likert scale their satisfaction level concerning the actual/current situation regarding UGS in both quality and quantity terms. This question was repeated at different spatial scales ranging from the participant's neighbourhood to the whole urban area of Thessaloniki. An important result that emerged from

these answers is that residents gave a very low score for their satisfaction with the existing UGS, no matter the spatial scale. Namely, in the case of the entire urban area, 90% of the participants evaluated the current UGS as below average (as indicated by a score of 5/10 or lower), while the mean value was found to be 3.2/10. When evaluating the green areas in their neighbourhood, below-average scores were assigned by 78% of the participants, while the mean value was found to be slightly higher (4.3/10). The spatial variation in these answers (based on the satisfaction level at the neighbourhood scale) is depicted in Fig. 1. This shows that, according to the citizens' objective perceptions, there are considerable differences and inequalities in the quality and availability of UGS. This spatial variation can be attributed to the variation among participants in their proximity to significant UGS (with respect to size and/or number) UGS. It is also worth noting that the lowest satisfaction levels were found in the historical centre of Thessaloniki (represented by a black circle in Fig. 1), where UGS are in fact very scarce.

Identifying the spatial patterns of human activity in UGS is likely to provide evidence of the utility of these elements, thus supporting future urban planning and management decisions (See et al. 2016). In this context, a spatial analysis was performed, using the QGIS 3.18 software, to geographically specify the locations of the green areas that the residents of Thessaloniki prefer to visit. An interesting outcome of this analysis is that more than half of the survey participants (61%) were found to visit green areas located either on the urban waterfront or are situated far from the city centre, in

Fig. 3 UGS visitor density map (qualitative indicator based on the sample data)

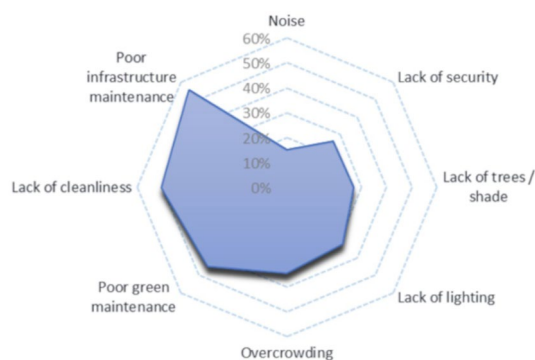
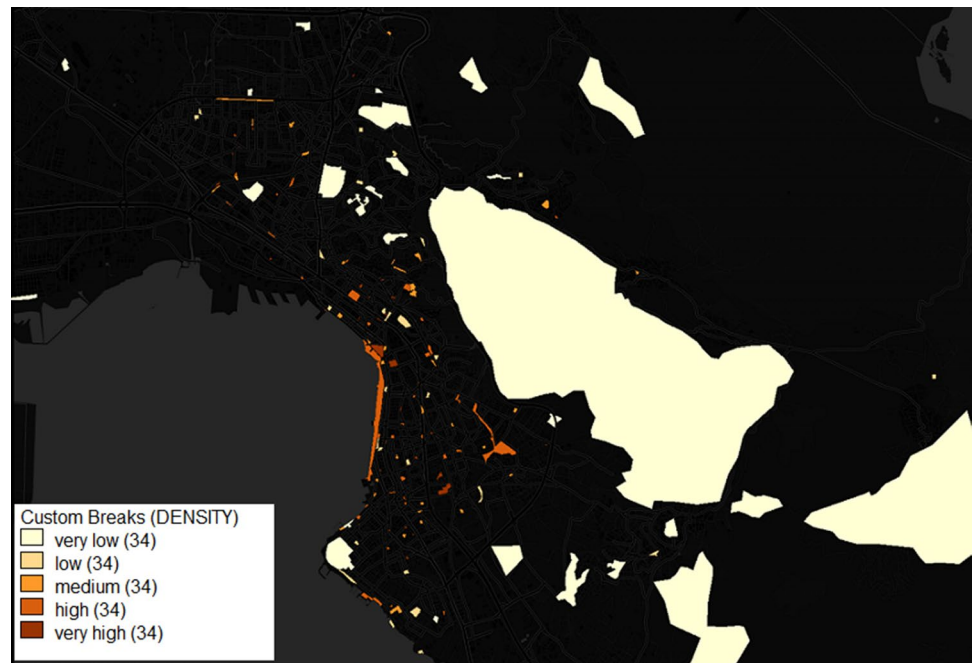


Fig. 4 Participants' rankings of existing problems with the UGS in Thessaloniki

some cases even on the outskirts of the city (e.g. in the suburban forest of Seich Sou as well as in many parks located in suburban municipalities). Consequently, only four out of ten residents choose to visit all the other UGS located within the urban fabric. Figure 2 shows a heat map based on the actual visits to the UGS by the citizens of Thessaloniki, which can help to identify the above-mentioned spatial hotspots of green space use (i.e. the most popular/visited UGS). Most of these hotspots areas are green parks, except the waterfront area, which is a newly regenerated open access space, stretching over 3.2km, with a wide promenade along the sea, featuring a bicycle line and lined with a chain of eight thematic parks (so the urban green space comprises the vegetation in these parks and the trees along the promenade) (Athanasidou 2021). Another important indicator related to

the usage of green space is the visitor density in the area. The first step in the creation of a visitor density map was to quantify the total number of observed visitors (based on the survey data) and their activity levels (according to their average time spent on-site) in terms of the total UGS area (visitors hour^{-1} hectare $^{-1}$). Then, a density index was created by classifying these results into five equal-sized groups (quintiles) ranging from very low to very high relative density (according to the actual data). Figure 3 presents this density map, which was created using the GeoDa spatial modelling software (Center for Spatial Data Science, The University of Chicago, Chicago, IL, USA, <https://geodacenter.github.io/>). In this figure, a dark-mode basemap (Carto Dark) was selected in order to highlight the UGS elements. It is worth noting that the last category (very-high density) is almost exclusively related to small green spaces.

Concerning the main motivations for selecting an urban green space, according to the survey results, the two most important criteria were distance (i.e. accessibility), which was reported by 80% of the respondents, and size/area (larger areas are particularly preferred as compared to the smaller ones), reported by 72% of the respondents. Apart from size, two other important motivations, which also reflect the functional level of green spaces, were the provision of sport/recreational activities (54.8% of respondents) and the provision of activities for children (28% of respondents). Concerning the main problems with existing UGS, the participants' rankings, as shown in Fig. 4, indicate that the three most important problems are (a) poor infrastructure maintenance (e.g. of benches, fences, playgrounds,

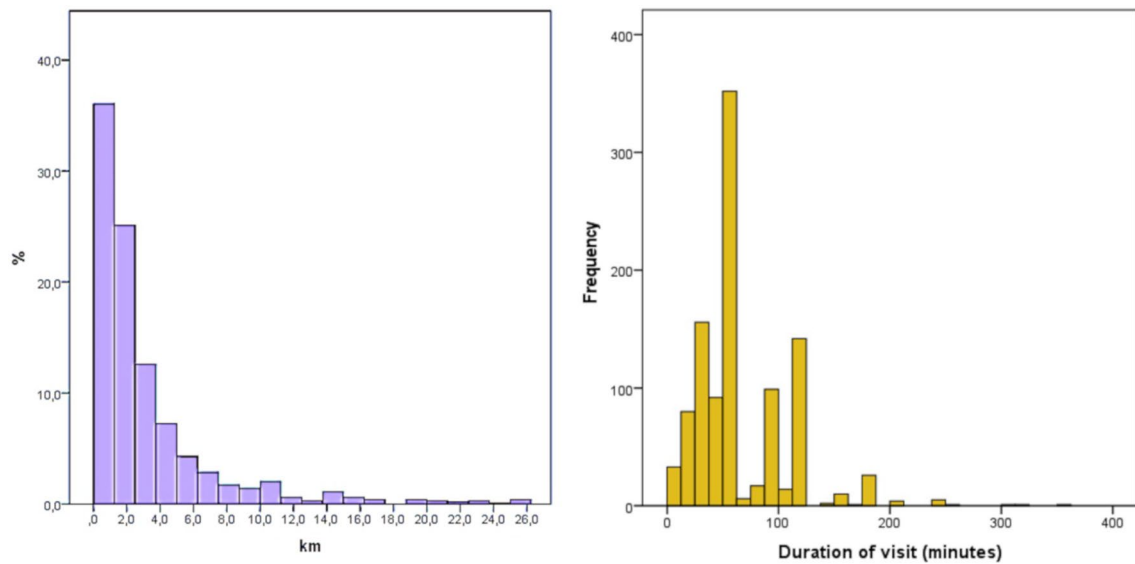
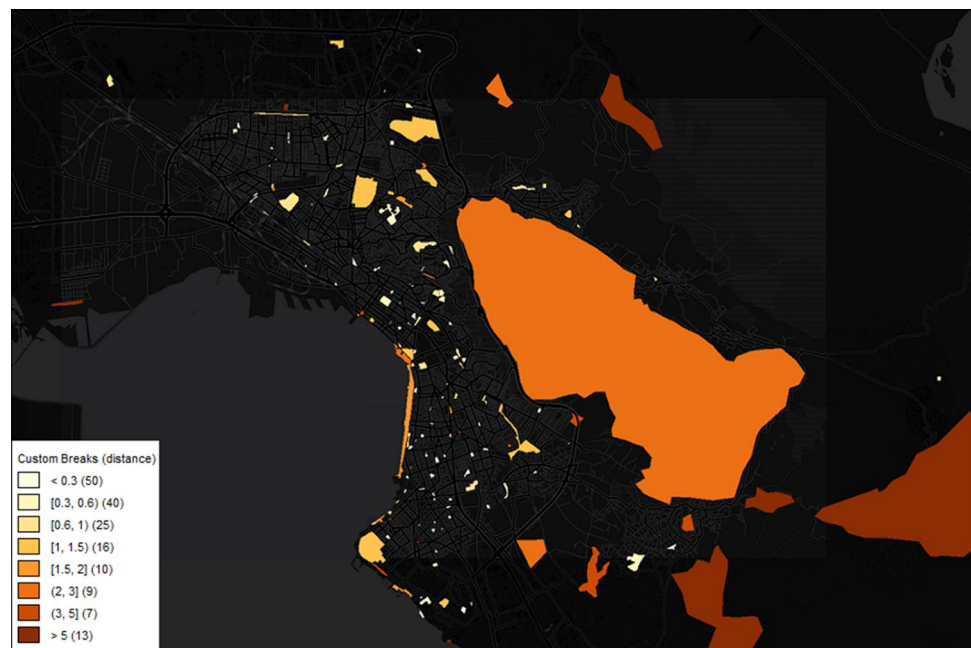


Fig. 5 Histograms of the distance travelled by a citizen to visit UGS (a) and the duration of their visit (b)

Fig. 6 Map of average distances travelled to visit a green space



etc.), (b) a lack of cleanliness and (c) poor green maintenance (i.e. poor care and maintenance of lawns, bushes and flower gardens).

As described in the methodology section above, the respondents were asked to mark on a map (through an interactive user interface) their home location and the location of the green space/park that they spent the most time. Based on these data, it was easy to estimate the average distance that a citizen travels in order to visit a green space (see Fig. 5a). The farther a visited place is from a respondent's home, the more likely it is that the green space has a positive wellbeing

influence (Samuelsson et al. 2021) and/or that the respondent has limited accessibility to UGS of an acceptable quality.

An important outcome of this analysis is that, on average, the citizens of Thessaloniki travel about 1.8 km (measured as the Euclidean distance). It is also worth mentioning that half of the respondents travel at least 1 km, while only 20% of the sample are visiting a green space at a distance of no more than 400 m, which is commonly used as the distance that indicates accessibility (i.e. walking distance) for all age groups (Van Jerzele and Wiedemann 2003). This outcome is very close to the estimation of Barboza et al. (2021), who found that 87.7% of

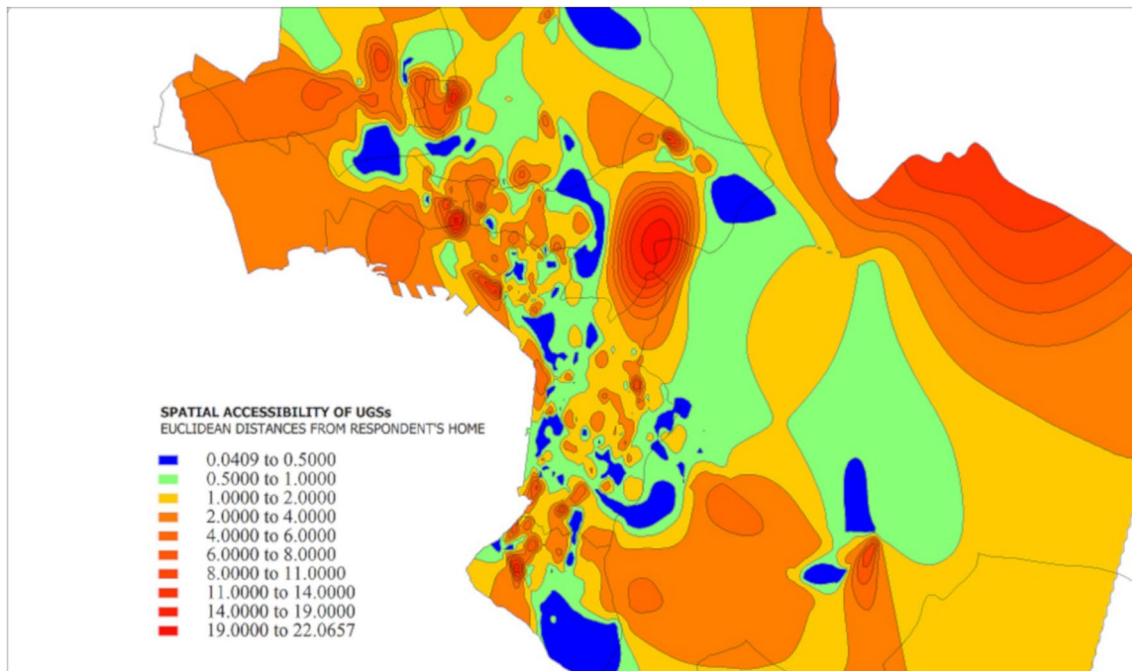


Fig. 7 Spatial accessibility of UGS

Thessaloniki's urban population did not meet the WHO standards for a healthy urban environment (i.e. green spaces of at least 0.5 hectares should be accessible within a linear distance of 300 m from their residence).² As a consequence of these findings, one in four residents never walks to an UGS, thus being forced to use some means of transport (car, bus, bicycle, etc.). Figure 6 shows a map of the average distances that citizens of Thessaloniki are travelling to visit a green space (once again a dark mode basemap was selected to accentuate the visualizations of the UGS data). It is worth mentioning that long distances are travelled not only in suburban/peri-urban green areas but also in some areas located within the urban fabric, most of which correspond to large UGS (e.g. green areas on the urban waterfront). It is also worth noting that the average distance travelled to visit 55 of the 171 sites (i.e. 32% of the UGS) is greater than 1 km. Figure 6 presents citizens' preferences for visiting green spaces, based on the locations of existing UGS (i.e. based on the actual supply of green space). On the other hand, in order to explore demand-driven spatial relationships as well as to assess the current spatial inequalities in UGS accessibility, it is necessary to estimate the travel distances with regard to the residence areas of the respondents. Thus, a map of spatial accessibility was developed (Fig. 7) by interpolating actual travel times from the residence point data over the study area. The resulting map shows the expected travel time

from any origin (residence) to a green space that is likely to maximize wellbeing.

The importance of visits to UGS can be valued non-monetarily by the total amount of time spent on-site (i.e. in UGS) during the citizens' visits. In this framework, it was necessary to estimate (a) the length of on-site stay, (b) the frequency of visits to UGS and (c) the time taken to travel (both ways) to visit green spaces. The duration of visits to UGS was examined for each respondent (according to their answer), and then the average duration of an on-site stay at each green space was estimated. As shown in Fig. 5b, the mean time spent on-site is equal to 67 min, while about 20% of the respondents spend 2 h or more in parks and other natural areas within the city. The time taken to travel to the UGS for each respondent (based on his/her pinpointed locations) was calculated using the Google Maps travel time estimator, while data concerning the frequency of visits to the UGS were also extracted from the questionnaire. Taking into account these data, it was then possible to estimate the average time that a citizen of Thessaloniki spends every year travelling to/from (45 h) and at (108 h) an UGS.

The importance of visits to UGS can be also valued monetarily using a travel cost method (TCM). The application of a detailed TCM was beyond the aim of this study (mainly due to the lack of other on-site expenses). Thus, a simplified TCM was used to value the benefits provided by the UGS of Thessaloniki, based on the opportunity cost of time spent (on the road and on-site), which is usually measured as a percentage of the wage rate. By using the aforementioned

² In our sample, 11.3% of the citizens are visiting a green space (of at least 0.5 hectares) at a distance of less than 300 m.

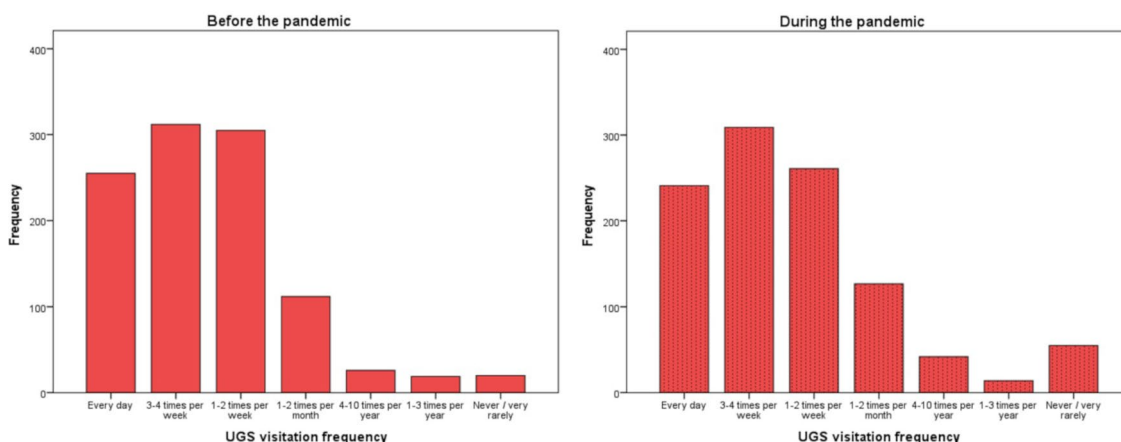


Fig. 8 Frequency of visiting UGS a before and b during the pandemic



Fig. 9 Results of the citizens' vote on the future use of the area

results and a conservative estimate (Bowker et al. 1996) for the opportunity cost of travel and/or leisure time (equal to 25% of the wage rate), it was possible to approximate the total value of recreational hours spent in UGS, which was found to be equal to 260 million euros per year. If we consider the on-site time to be positive (i.e. a benefit and not a cost) and subtract it from the analysis, the total value of this recreation is equal to 83.4 million euros per year.

As already mentioned, the demand for urban parks and outdoor green spaces all over the world has increased since the pandemic outbreak (except for the period of strict lockdown restrictions during the first month). This fact highlights the important role and the benefits provided by green spaces, and particularly by UGS, during the COVID-19 pandemic (Geng et al. 2021). However, in Thessaloniki,

the small number and sizes of green spaces, the long distances between homes and UGS, and the restrictive measures implemented due to the pandemic make it very difficult (or even impossible) for large population groups to visit green areas over a very long period. So, as the study results confirm, the frequency of visits to green spaces has not increased during the pandemic; on the contrary, it has slightly fallen (as depicted in Fig. 8). Namely, 83.1% of the respondents stated that before the pandemic they visited a green area at least once a week, while this percentage decreased to 76.9% during the pandemic. This outcome reveals that the city of Thessaloniki has a low resilience to the COVID-19 pandemic, as it partially failed to adapt to the pandemic disturbance, and thus failed to sustain the wellbeing of urban residents.

All of the above confirm the need to reconsider the current urban planning strategies and to integrate new green spaces into the urban environment of Thessaloniki. One of these potential sites is the area where the Thessaloniki International Fair (TIF) is located. The redevelopment/transformation of this site into a large metropolitan plan was one of the key elements of the city's masterplan to address the environmental and spatial problems the city is facing. A previous study (Latinopoulos et al. 2016) has shown that the residents of Thessaloniki attribute very high value to transforming this area into a large metropolitan park. The provision of new walking/leisure/activity areas and the contribution to residents' wellbeing (in terms of aesthetic value and air quality improvements) emerged as the most important benefits of this project. However, this option has been recently overshadowed by a renovation project with significant exhibition areas and commercial uses (including new hotel infrastructure) but limited public green space. So far, the issue of citizen participation in

the planning process has been quite problematic. Hence, in order to explore the residents' views about the future use of this space, they were asked (in the context of this study) to choose between the two different scenarios described above: (a) the recently proposed renovation project or (b) the creation of a large metropolitan park. According to the survey findings (shown in Fig. 9), the vast majority of the respondents (78.4%) opted for the metropolitan park, emphasizing in their individual comments that a large urban green park is more than necessary for the city of Thessaloniki. This outcome validates the previous results of Latinopoulos et al. (2016) about the social preferences implied by this site/project, confirming once more that urban parks and green spaces are extremely important for the wellbeing of the citizens of Thessaloniki.

Conclusions

It is a common belief that the popularity of UGS in Thessaloniki is growing; their significance is increasingly being recognized due to their ability to improve the city's resilience to environmental (e.g. climate change) and health (e.g. the COVID-19 pandemic) risks. Therefore, it was essential to get more information about the demand for and the value of UGS. In this framework, a public survey was conducted to shed some light on the citizens' attitudes, satisfaction level, actual behaviour towards and future expectations about UGS in Thessaloniki. The results of this survey demonstrate that there are many reasons to invest in urban green infrastructure options. The potential benefits of such investments are expected to be substantial, as citizens are dissatisfied with the current green areas and are very supportive of the development of new (and especially large-scale) green projects. Therefore, the planning and development of new UGS in Thessaloniki is a demand-driven and cost-effective option that city planners and local authorities should consider in their future decisions.

Future research on this topic will focus on identifying the specific areas that are most in need of new or improved UGS, by coupling the subjective perceptions of citizens with objective spatial data/indicators. In other words, a planning support tool for optimizing location of new green infrastructure could be developed. Finally, the survey could be replicated in other Greek, or even Mediterranean cities, in order to identify similarities and differences in the preferences, values and expectations of citizens regarding UGS.

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Declarations

Conflict of interest The author has no competing interests to declare that are relevant to the content of this article.

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