EVALUATION OF THE URBAN GREEN INFRASTRUCTURE USING LANDSCAPE MODULES, GIS AND A POPULATION SURVEY: LINKING ENVIRONMENTAL WITH SOCIAL ASPECTS IN STUDYING AND MANAGING URBAN FORESTS

Jose Antonio Gonzalez-Duque
Thomas Panagopoulos

ABSTRACT

Modern cities have to reconcile the needs of the citizens for green areas considering the evolutionary trends of the city, especially in terms of growth and the required transformation in modern times. The present study attempts to analyze and evaluate the amount and distribution of the existing urban green space and the requirements of those green areas by the public. The green infrastructure of the city of Faro was evaluated with three methods: landscape assessment using modules, spatial assessment using GIS and social assessment using an urban population survey. This research provided indicators and thresholds to be included by policy makers in local regulations about green infrastructure of the city of Faro.

Keywords: Cityscape, Urban Green Network, Evaluation of Green Areas, Urban Forestry

JEL Classification: Q28, Z18, Z13

1. INTRODUCTION

In recent times Green Infrastructure (GI) has gained importance as a planning tool for regional and urban sustainability (E.E.A. 2011). Attention is also given to the environmental services provided by GI in the context of city resilience and climate change adaptation and mitigation. As the urban population increases, so do diverse urban problems and concerns including issues of servicing large numbers of people within existing infrastructures, as a result of over-development and over-concentration. Environmental problems, particularly air and water pollution, have become more evident and are now considered central issues for urban planners and decision-makers (Oh et al., 2005). A well-structured urban forest mitigates temperature; absorbs air, soil and water pollutants; and decreases acoustic pollution, water run-off and soil erosion (Jankovska et al., 2010; Ferreira and Panagopoulos, 2012).

It is acknowledged that, alongside environmental services, GI can also provide a number of social benefits or cultural ecosystem services for a range of uses (Goličnik and Ward, 2010). Urban green spaces (UGS) form an integral part of any urban area, and quantity and quality of UGS are of prime concern for planners and city administrators (Gupta et al., 2012). UGS create opportunities for recreational activities which contribute to people's health, well-being and quality of life, particularly in relation to their capacity to provide environments which help to alleviate stress (Gonzalez-Duque and Panagopoulos, 2010). The ameliorating thermal effect induced by green areas inside the warm, urban microclimate of densely populated cities can improve the thermal comfort, as well as the overall health and living conditions of their inhabitants (Papangelis et al., 2012).

The design of urban landscapes strongly influences the well-being and behavior of users and nearby inhabitants (Matsuoka and Kaplan, 2008). The aesthetic qualities they bring to spaces can help improve the sense of place and make the city more appealing to live in (Panagopoulos, 2009). It has also been suggested that GI can have a positive impact on social interaction and inclusion, providing spaces for use by the whole community. Furthermore, UGS are valuable in terms of education and learning, helping people to 're-connect' with nature and educating them about its continued relevance in their lives.

The processes and management in past traditional landscapes and the manifold relations people have towards the perceivable environment, and the symbolic meaning it generates, offer valuable knowledge for more sustainable planning and management for future landscapes (Antrop, 2005). The concept of landscape broadens and differentiates according to the context. Concepts such as natural, human, social or quality of life capital are principally expressions of this broadening. They are attempts to formulate new frameworks adapted to specific visions or conditions of the landscape (Antrop, 2006). The urbanized landscapes are highly dynamic, complex and multifunctional. Therefore, detailed inventories of landscape conditions and monitoring of change are urgently needed in order to obtain reliable data for good decision-making (Antrop, 2004).

Cultural identity is strongly associated with the ways in which people interact with their landscapes. A few special landscapes may have 'universal' or 'outstanding' values, but almost all landscapes will be valued in multiple ways by those people who are closely associated with them (Stephenson, 2008). Since the social values of urban woodlands are not always sufficiently taken into account in decision-making on urban land-use and green space planning, new means of collecting the experienced values of urban green areas and integrating this information into the planning processes are needed (Tyrväinen et al., 2007).

The cities are complex ecosystems affected by social, economic, environmental and cultural factors. The problem of attaining urban, sustainable development is thus an important challenge. The development of evaluation indicators and a method for assessing the status of urban sustainable development will be required to support urban, ecological planning (Li et al., 2009). Rapid urbanization has caused many environmental impacts associated with the reduction of green space. Having realized the important role of green space in urban ecosystems, many local governments in China have set out a series of policies to introduce green elements into urban areas (Zhou and Wang, 2011). Accordingly, the urban landscape is becoming increasingly important for maintaining biodiversity on site, as well as for understanding the concept of biodiversity in general, and its maintenance in urban landscapes (Sandström et al., 2006). The need for suitable planning strategies to reduce landscape fragmentation favoring energy and matter fluxes between ecosystems, while preserving biodiversity, is a key issue of nature conservation and sustainable development (Gobattoni et al., 2011). Making landscape functions explicitly spatial adds an important component to research conducted in the field of quantification of landscape goods and services (Willemen et al. 2008).

Attitudes influence behavior towards urban green spaces, but determining attitudes toward urban green spaces is not operationalized well in urban planning research (Balram and Dragićević, 2005). Human attribution of multiple values to landscapes is not well understood owing to the variability and complexity of both the landscape concept and the human valuation process (Brown and Brabyn, 2012; Panagopoulos, 2012). In China, rapid urbanization has profoundly transformed the spatial pattern of urban land use, including urban green spaces. The government plans to optimize green spaces to integrate with urban development; this requires an understanding of the process of green space change. Quantification of green space patterns is a prerequisite to understanding green space changes, and it is essential for monitoring and assessing green space functions (Kong and Nakagoshi, 2006).

According to Ryan (2011), landscape planners in the future will need to know as much about the social landscape as they do the physical landscape before embarking on planning actions. Attitudes toward urban green spaces include: an integrating questionnaire survey and collaborative GIS techniques to improve attitude measurements. The citizens are making greater demands for a more active role in the planning and decisions that are made about the green spaces in their communities. These demands are motivated by reasons such as: a desire to improve the quality of community life, environmental protection, participation in decisions that will affect their lives, concern for social conditions and a need for satisfaction with their surroundings (Balram and Dragićević, 2005).

The objective of this research was to evaluate the green infrastructure of the city of Faro and examine if it meets the desires (needs) of the population. In this paper the amount and distribution of the green areas of the city of Faro were assessed with three different methods. In the first method landscape modules were used, as described in Gonzalez-Duque and Panagopoulos (2012); in the second method the green areas based on GIS technology were assessed and linked; and in the third method the relationship regarding green areas and urban population was studied with a survey.

2. METHODOLOGY

1. The study objects of this article are the urban green areas and the opinion of the citizens of Faro (Portugal) by the method of direct survey. This research integrates spatial variables (methods one and two) with social variables (third method). The data collection methods have been taken by direct observation, digital mapping (GIS software), statistical functions and questionnaires. Instruments used for the study and data analysis are: software such as ArcGIS, CAD and statistical software such as SPSS. The following hypotheses were studied: Do the different urban areas have different needs in green area or similar? Does GI affect the existence of green areas and, if so, likewise influences the distribution and size of green areas in appetite (need) of green space for citizens?

2.1. The Study Area. The landscape of Faro city

The Algarve region in Portugal is often considered as one of the most appealing regions for tourism in the country. Its attractive location and moderate climate have brought increasing economic prosperity since the mid-1960s (Noronha Vaz, Eric de, et al., 2012). Those kinds of metrics are highly applicable to the study of urban landscape dynamics and processes. This is especially true for Southern European cities, given the acceleration of their urban growth processes (Aguilera F., et al., 2011). Urban land employs scenarios for a tourist region in Europe. Urban growth arises from the increase in population, particularly due to tourism and economic change. However, the spatial patterns are different due to alternative assumptions about urban development processes/purposes (Petrov, L.O., et al., 2009).

The city of Faro is surrounded to the north, east and west by the countryside of Faro, offering gentle relief and soils with high agricultural capacity (alluvium) which is dominated by intensive agriculture irrigation, horticulture and vineyards with predominantly greenhouse crops and fruit trees. To the south of the city, by the Atlantic Ocean, the Natural Reserve Park of Ria Formosa is located, which has great natural wealth. In the urban area of the city of Faro, there is a multitude of species of both trees and shrubs that make up the different areas of the urban landscape.

An inventory of Faro refers to a variety of public spaces: alignments, plazas, squares, gardens and parks. The highlight for its size is the garden “Alameda João de Deus” located along the Rua da Segurança, the Police Post, and the wooded park located in the Liceo surrounded by the Rua de Berlim; within these two elements, there is a wide variety of plant species of herbaceous, shrub and tree.

2.2. Urban Structure

Current research on sustainability of cities has favored the implementation and conservation of greenery in the urban context. The benefits of plants are not just environmental but recreational, aesthetic and emotional (Ong, B.L., 2003). The term ‘landscape’ focuses upon the visual properties of the environment, which include natural and man-made elements and physical and biological resources that could be identified visually; it also includes non-visual biological functions, cultural/historical values, wildlife and endangered species, wilderness value, opportunities for recreation activities and a large array of tastes, smells and feelings (Panagopoulos, T., 2009). Green space around settlements is increasingly important for recreation. However, recreation managers have limited spatially explicit data on recreation potential around cities, and representative field data are expensive to gather (Kienast, F., et al., 2012).

Nowadays you can see Faro progress and differentiate into four areas or general areas:

1. Vila-a-Dentro: the old city center with homogeneous architectonic characteristics, harmony in building typologies and irregular borders.
2. Zona de Extramuros: a zone with heterogeneous characteristics, buildings in blocks of low and average density and neighborhood gardens, open spaces and avenues.
3. Periferia Urbana: a zone of high buildings in blocks of high density, with an absence of connection and with disarticulated public space.
4. Area de Expansion: a zone of high buildings in blocks of high density and an absence of public space.
5. For the application of the three methods, it has been divided into seven areas of urban characteristics and similar landscaping (fig. 1).

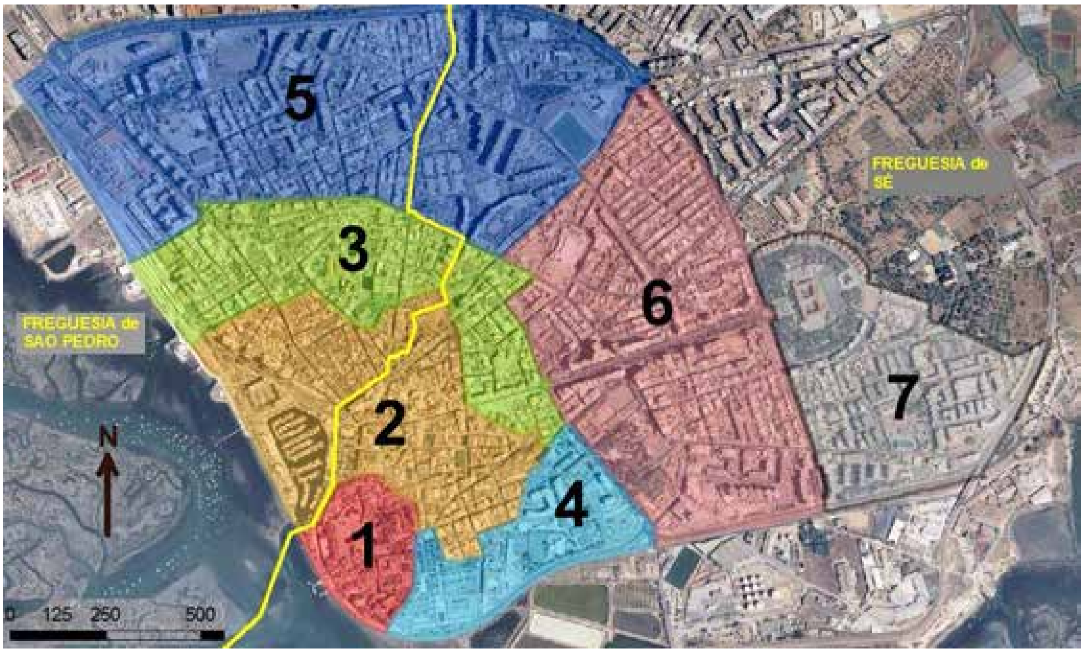


Fig. 1. Faro (Portugal) division into seven zones

2.3. Landscape Modules method

2.3.1. Description of the vegetation modules

The landscapes modules method is based on the doctoral thesis of Gonzalez Duque (2011). A basic element method explained and utilized in this study is the variable upon which the suggested methodology has been developed. The variable in question is the Vegetation Module (VM). The VM evaluates a facet of the quality of urban vegetation based on other objective parameters, depending on the urban environment as well as the feature being studied. The evaluation of the urban landscape is done through the calculation of the VM using the parameters streets, buildings and vegetative elements (Gonzalez-Duque and Panagopoulos, 2012).

There are six basic, analytic VM: three of them refer to constructive or structural elements: non-vegetative elements (Modules I, II, and III - "Evaluation Constructive Elements" - ECE), and another three, which are vegetative elements (Modules IV, V, and VI - "Evaluation Vegetative Element"- EVE).

2.3.2. Indicator pattern method in relation to urban green areas (IPRUGA)

For weight with Green Zones within the cities, a new empirical method has developed, which has not been taken from previous normalizations. The results obtained with this method are quantitative and indicate whether the surface of green areas in a city is adequate or not.

Table 1 shows the "Indicator Pattern in Relation to Urban Green Areas (IPRUGA)". The IPRUGA is defined as: (IPR1 + IPR2 + IPR3) / 6. Where:

IPR1 = Buildings / Green Areas (The objective of this first application is to establish a direct link between buildings and green areas).

IPR2 = (Buildings + Roads-sidewalks) / (Green Areas + Open Space) (The numerator is reflected categories that are not eligible to become a Green space and the denominator is current and possible future Green space).

IPR3 = (Buildings + Roads-sidewalks + Open Spaces) / Green Areas (is based on the worst case that the "vague" will not become part of the green areas).

Table 1: Range of values that can take the method IPRUGA in each application area

TABLES
Indicator Pattern in Relation to Urban Green Areas (IPRUGA)

Abbreviation	Urban space types
GA	Green Areas
OS	Open Space
RS	Roads-sidewalks
B	Buildings

Ipruga elements	Urban elements
IPR1	B / GA
IPR2	(B+RS) / (GA+OS)
IPR3	(B+RS+OS) / GA

IPRUGA VALUES	
Excellent	$0 \leq I \leq 1$
Very Good	$1 < I \leq 1,5$
Good	$1,5 < I \leq 2,5$
Middle	$2,5 < I \leq 4,5$
Middle low	$4,5 < I \leq 6,5$
Low	$6,5 < I \leq 8,5$
Very low	$8,5 < I \leq 10$

IPRUGA: (IPR1 + IPR2 + IPR3)/6

2.4. Method of Citizen Survey

The purpose of conducting a survey of the population of the city of Faro is to know the opinion of the inhabitants of the city of Faro on the use and enjoyment of green spaces and their preferences for them.

The research variables have been specified, focusing on the different types of Landscape (Garden, Park, Plaza, Alignments, scattered plants and/or grass and plants in containers) and their current status (maintenance, accessibility, location , ...).

This questionnaire will provide the different opinions and thoughts of the inhabitants of the city on the green areas that are surrounding them.

3. RESULTS

3.1. Result of the Method Vegetation Modules

After applying the vegetation modules to each study area, ECE and EVE values of each city zone were obtained. The results can be seen in figure 2 showing that most zones present a negative, unbalanced rating.

- Zones 4 and 7 were those that best meet the needs of green areas for the city of Faro according to the ECE and EVE values. The zone 4 was the best and most balanced and zone 7 was good but not as balanced as above.
- Zones 1, 2 and 3 present values that are generally unbalanced and streets with very few green areas.
- Zone 5 follows the same trend as previous areas but is somewhat better (than 1, 2 and 3).
- Zone 6 has enough green areas in relation to the characteristics of the streets.

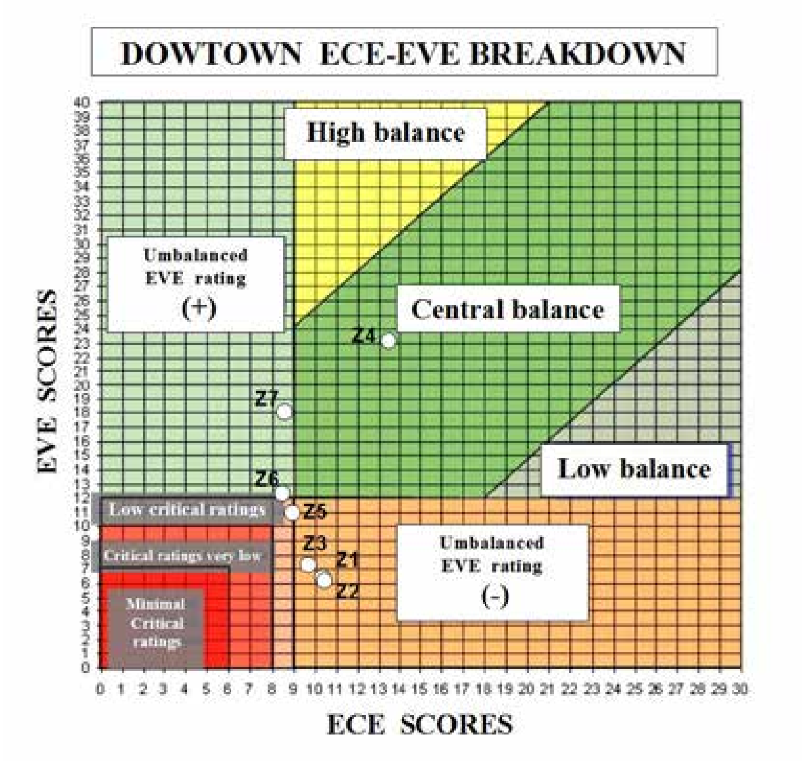


Fig. 2. Relation matrix ECE-EVE study area

3.2. Result of the Method of Indicator Pattern in Relation to Urban Green Areas (IPRUGA)

The estimation of the surface of urban elements (GA, OS, RS, B) for calculating IPRUGA can be seen in table 2 and figure 3. In figure 3 it can be seen as a graphic representation of the IPRUGA assessment for the city of Faro. In figure 4 it can be seen as the surface of urban elements for calculating IPRUGA by zones.

Table 2. Estimation of the surface of urban elements for calculating the Indicator Pattern in Relation to Urban Green Areas (IPRUGA)

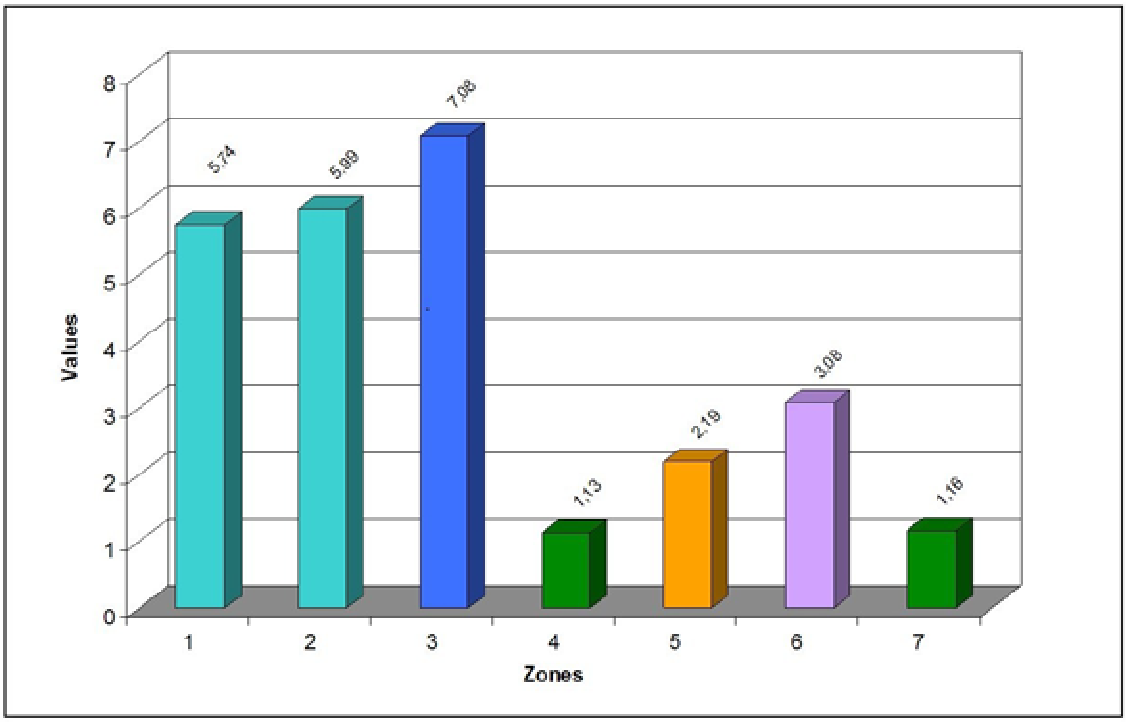
Estimation of the surface of urban elements (GA, OS, RS, B) for calculating IPRUGA (Indicator Pattern in Relation to Urban Green Areas)				
Zones	GA(%)	OS (%)	RS (%)	B (%)
1	7,23	0	29,07	63,69
2	6,72	0,51	30,55	62,22
3	5,62	0,36	37,85	56,16
4	24,12	5,47	39,86	30,54
5	14,48	3,92	40,76	40,85
6	12,14	1,22	28,98	57,66
7	26,41	1,98	28,8	42,81

As shown in the graph of figure 3, the results can be classified in three groups:

- A first grouping would consist of a zone 1 with green zone of 7.23%, Zone 2 with 6.72% and zone 3 with 5.62% which would be a significant shortage of green areas.
- A second grouping consists of zones 5 and 6 which had 14.48% and 12.14% of green areas respectively.
- The third group consists of zone 4 with 24.12% of green areas and zone 7 with 26.41%, both having very good assessment areas.

The Indicator Pattern in Relation to Urban Green Areas (IPRUGA) method provided a useful and practical tool to establish a proper classification of green space, referencing the urban fabric. The ranges of the classification can be a clear reference of green areas that should exist in a city. In the study area there are three areas of acute shortage of green areas with high building density and two areas with very good assessment of green areas.

INDICATOR PATTERN IN RELATION TO URBAN GREEN AREAS (IPRUGA)



ZONES: Indicator Pattern in Relation to Urban Green Areas (IPRUGA)		
ZONES	EVALUATION	VALUES
1	Middle low	5,74
2	Middle low	5,99
3	Low	7,08
4	Very Good	1,13
5	Good	2,19
6	Middle	3,08
7	Very Good	1,16

VALUES: Indicator Pattern in Relation to Urban Green Areas (IPRUGA)		
Excellent	$0 \leq I \leq 1$	(yellow)
Very Good	$1 < I \leq 1,5$	(dark green)
Good	$1,5 < I \leq 2,5$	(orange)
Middle	$2,5 < I \leq 4,5$	(lilac)
Middle low	$4,5 < I \leq 6,5$	(turquoise)
Low	$6,5 < I \leq 8,5$	(blue)
Very low	$8,5 < I \leq 10$	(red)

Figure 3. Graphic representation of the IPRUGA valuation

Fig. 4. Surface of urban elements for calculating by zones the Indicator Pattern in Relation to Urban Green Areas

3.3. Overall results of the survey to the citizens

According to the survey method, interesting results were found for each of the city zones that link with the results of the other two methods. In this paper the 7th question of the study is presented as a sample.

Zone 1: public green areas have an intermediate position in relation to other areas.

Zone 2: about 40% of people believe there are enough green areas near their homes.

Zone 3: the views of local residents have been very diverse with 70% of responses in the range between low and fairly close to the green areas of their homes.

Zone 4: about 60% of the population surveyed in Zone 4 think that the proximity of green areas to their homes is quite good (52.6%) or acceptable (10.5%).

Zone 5: most people surveyed believe that the green areas are poorly (23%), fair (29.2%) and significantly (38%) near their homes.

Zone 6: almost 50% of the population surveyed in this area believe that the green areas are fairly close to their homes.

Zone 7: the vast majority of the surveyed population believed that the green areas were fairly close to their homes (42.2%).

Results from the 7th Question of the survey can be seen in the figure 5 in table 3. The survey can be seen in Appendix A (Supplementary data).

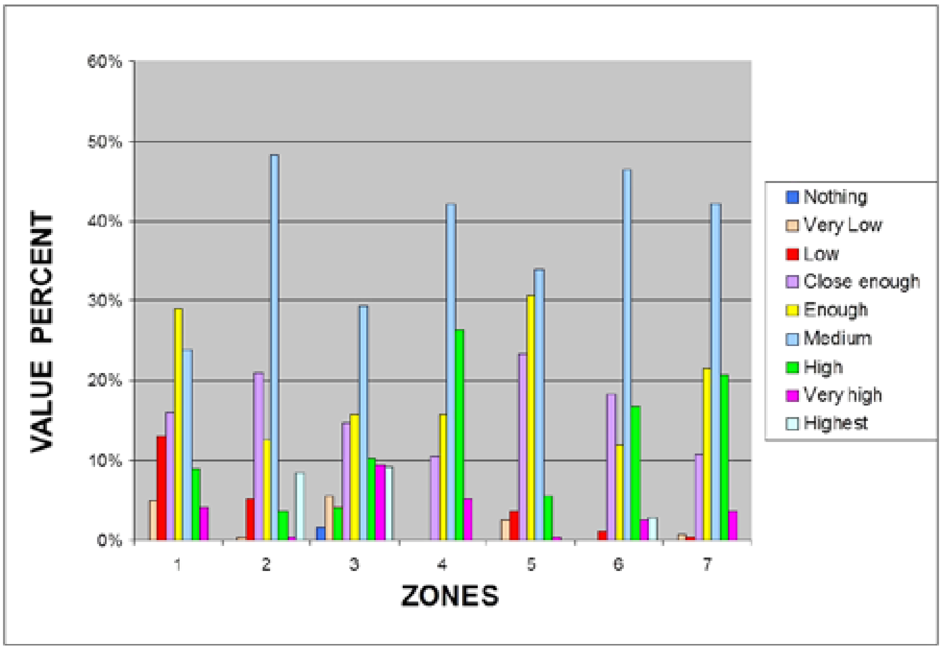


Figure 5. Graphical results of question number 7 of the citizen survey

Table 3. Valuation of the distance of the citizen green areas from home (Results of the 7th question of the survey)

	ITEMS / VALUE	CITIZEN	ZONE NUMBER						
		PERCENT	1	2	3	4	5	6	7
ACCESIBILITY	1: Nothing	CITIZEN - 1	0	0	4	0	0	0	0
		PERCENT - 1	0.00%	0.00%	1.60%	0.00%	0.00%	0.00%	0.00%
	2: Very Low	CITIZEN - 2	5	1	14	0	7	0	2
		PERCENT - 2	5.00%	0.40%	5.60%	0.00%	2.60%	0.00%	0.80%
	3: Low	CITIZEN - 3	13	13	10	0	10	3	1
		PERCENT - 3	13.00%	5.20%	4.00%	0.00%	3.60%	1.10%	0.40%
	4: Close enough	CITIZEN - 4	16	52	37	4	64	50	27
		PERCENT - 4	16.00%	21.00%	14.70%	10.50%	23.40%	18.20%	10.80%
	5: Enough	CITIZEN - 5	29	31	40	6	84	33	54
		PERCENT - 5	29.00%	12.50%	15.90%	15.80%	30.70%	12.00%	21.50%
	6: Medium	CITIZEN - 6	24	120	74	16	93	127	106
		PERCENT - 6	24.00%	48.40%	29.40%	42.10%	33.90%	46.40%	42.20%
	7: High	CITIZEN - 7	9	9	26	10	15	46	52
		PERCENT - 7	9.00%	3.60%	10.30%	26.30%	5.50%	16.80%	20.70%
	8: Very high	CITIZEN - 8	4	1	24	2	1	7	9
		PERCENT - 8	4.00%	0.40%	9.50%	5.30%	0.40%	2.60%	3.60%
	9: Highest	CITIZEN - 9	0	21	23	0	0	8	0
		PERCENT - 9	0.00%	8.50%	9.10%	0.00%	0.00%	2.90%	0.00%
	10: Maximum	CITIZEN - 10	0	0	0	0	0	0	0
		PERCENT - 10	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
TOTAL		CITIZENS	100	248	252	38	274	274	251

4. DISCUSSION BETWEEN THE RESULTS OBTAINED IN THE DIFFERENT METHODS OF ASSESSMENT OF LANDSCAPE

The results of the three methods: Landscape Modules method, Indicator pattern in relation to urban green areas (IPRUGA) and Method of citizen survey were analyzed independently and jointly.

We can consider that areas 1, 2 (medium-low valuation) and 3 (low assessment), due to a shortage of green areas and existing ones, are removed. Zones 4 and 7 rated as very good due to the amount of green space and, therefore, the relative proximity to their homes. Zones 5 (good) and 6 (average) actually occupy an intermediate position in both green areas and in the opinion of citizens (opinion good and sufficient in relation to green areas).

Zone 1. According to the population survey method in Zone 1, green areas have an intermediate position. This seems contradictory when compared with the results of the other two methods (method of landscaping modules and methods based on GIS technologies) that obtained data that Zone 1 lacks green areas based on the urban fabric. This apparent contradiction is justified by the small area of Zone 1, which allows residents of this area to take advantage of the green areas of the surrounding areas.

Zone 2. In Zone 2, according to the method of survey population, about 40% of people believe they are close enough to green areas from their homes. For both modules in the method of landscape, as in the method of GIS technology, we have obtained data that the green areas of Zone 2 are limited to the urban fabric that has the zone.

Zone 3. In the method of population survey, the views of local residents have been very diverse. Method 3 found 70% of responses in the range between low and fairly close to the green areas of their homes. This can be justified for the other two methods. In the method of modules landscape, data was obtained that only 40% of streets have enough green spaces in terms of its urban fabric. Furthermore, the application of the GIS technology in this area of study also supports the results that Zone 3 has very few green areas to the urban fabric that it has (only 5.62% of the area are green areas).

Zone 4. About 60% of the population surveyed in Zone 4 think that the proximity of green areas to their homes is enough (52.6%) or acceptable (10.5%). These responses are confirmed by the other two methods applied where Zone 4 perfectly fits the needs of green areas.

Zone 5. Most people surveyed in Zone 5 believe that the green areas are poorly (23%), fair (29.2%) and significantly (38%) near their homes. These responses are justifiable as Zone 5 has 14.48% landscaping. The results obtained in applying the method IPRUGA also support these responses as data obtained in the green areas of Zone 5 are good.

Zone 6. Almost 50% of the population surveyed in this area believe that the green areas are fairly close to their homes. Also, in the method of landscape modules, half the streets of study in this area are in balance. All of this can be justified by how close they are to Zone 4 and Zone 7, which are areas with plenty of green areas that can be enjoyed by people in Zone 6 and other areas of study. The method IPRUGA demonstrates that the average values of this area as a zone agrees with the opinion of the surveyed population in proximity to the satisfaction of the green areas.

Zone 7. The vast majority of the surveyed population in Zone 7 believes that the green areas are fairly close to their homes (42.2%). They also agree with the answers of the other two methods, qualifying Zone 7 as very good in green areas.

Despite the experimental nature of this study, investigative developments have implications for future research and management in the urban environment.

The results also have implications for managers and researchers of urban planning as to the best way to assess the perceptions of citizens and visitors. If the goal is to understand the perception of green areas, questions should be asked directly about the green areas, proximity, characteristics, scope, requirements, etc. using decimal valued questions for better and more accurate assessment of the various views.

Another research implication relates to the fact that three methods have been applied very differently on any one target "Evaluation of the urban green infrastructure", the only relationship, for a result as close as possible to a target result.

The utility of an integrated approach that uses three methods could help in the creation, distribution and sustainable management of urban green areas and opportunities for outdoor recreation that are needed for citizens (fig. 6).

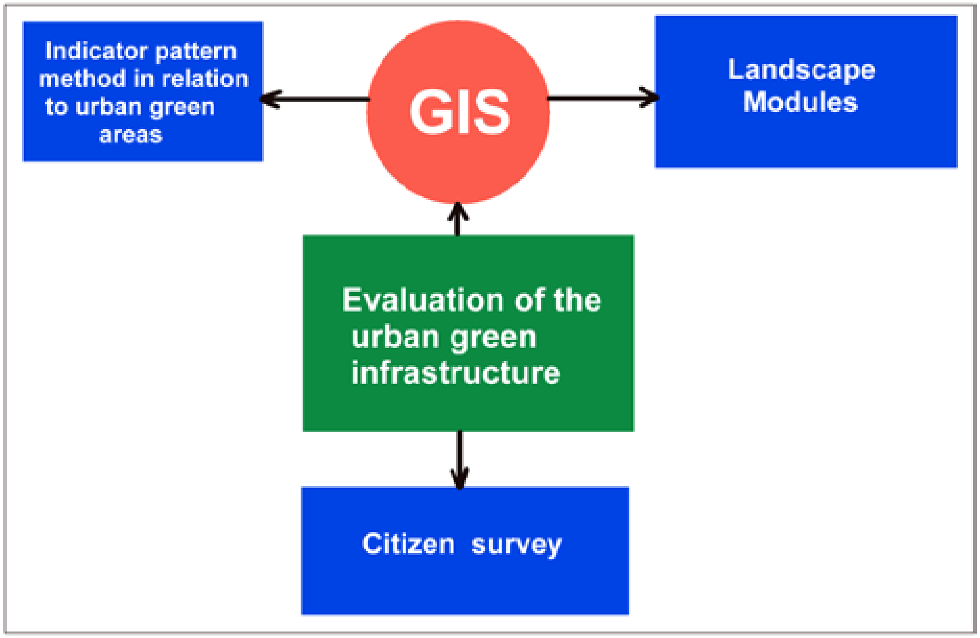


Fig. 6. Three methods of evaluation of the urban green infrastructure

5. CONCLUSIONS

This research created evidence on the distribution of ecosystem services from GI which may help to better design the city GI for the maximization of social and environmental benefits and a more equitable distribution. From the assessment of the GI of Faro by three different methods, the following conclusions were reached:

1. The interest of the population in the green areas is directly proportional to the amount of these that are near their homes.
2. In areas with a good value in the method IPRUGA, the survey population also states a greater interest in green areas (such as Zone 4).
3. The establishment of green areas in cities promotes the public interest in plants and nature in general. The proximity of green areas is encouraged to participate and enjoy more of the same.
4. In all three applied methods, the results have the same tendency for each of the city areas.
5. These evaluation methods are intended to help improve planning of GI to meet the needs of the urban population because the benefits of plants in the cities are not only environmental but also recreational, social and aesthetic.

6. This research provided indicators and thresholds to be included by policy makers in local regulations about GI of the city and may help to develop guidelines for GI planners and managers on how to implement GI approaches with an emphasis on linking the environmental and social services of urban forestry.

REFERENCES

Aguilera F., Valenzuela, L.M., Botequilha-Leitão A., 2011. Landscape metrics in the analysis of urban land use patterns: A case study in a Spanish metropolitan area. Landscape and Urban Planning, 99, pp. 226-238.

Antrop, M. 2004. Landscape change and the urbanization process in Europe. Landscape and Urban Planning, 67, pp. 9-26.

Antrop, M., 2005. Why landscapes of the past are important for the future. Landscape and Urban Planning, 70, pp. 21-34.

Antrop, M., 2006. Sustainable landscapes: contradiction, fiction or utopia? Landscape and Urban Planning, 75, pp. 187-197

Balram, S., Dragićević, S., 2005. Attitudes toward urban green spaces: integrating questionnaire survey and collaborative GIS techniques to improve attitude measurements. Landscape and Urban Planning, 71, pp. 147-162.

Balram, S., Dragićević, S., 2005. Attitudes toward urban green spaces: integrating questionnaire survey and collaborative GIS techniques to improve attitude measurements. Landscape and Urban Planning, 71, pp. 147-162.

Brown, G. Brabyn, L., 2012. An analysis of the relationships between multiple values and physical landscapes at a regional scale using public participation GIS and landscape character classification. Landscape and Urban Planning, Landscape and Urban Planning, 107, pp. 317-331.

EEA (European Environment Agency) 2011. Green infrastructure and territorial cohesion. The concept of green infrastructure and its integration into policies using monitoring systems. Publications Office of the European Union, Luxemburg.

Ferreira, V., Panagopoulos, T. 2012. Predicting Soil Erosion Risk at the Alqueva Dam Watershed. Spatial and Organizational Dynamics, 9:60-80.

Gobattoni, F., Pelorosso, R., Lauro, G., Leone, A., Monaco, R. 2011. A procedure for mathematical analysis of landscape evolution and equilibrium scenarios assessment. Landscape and Urban Planning, 103, pp. 289-302.

Goličnik, B., Ward T.C. 2010. Emerging relationships between design and use of urban park spaces. Landscape and Urban Planning, 94, pp. 38-53.

Gonzalez-Duque, J.A., Panagopoulos, T. 2010. Urban planning throughout environmental quality and human well-being. Spatial and Organizational Dynamics, 4, pp. 7-20.

Gonzalez-Duque, J.A., Panagopoulos, T., 2012. Vegetation Modules for evaluation of urban green areas. Recent Researches in Environmental Science and Landscaping, pp. 111-117, available at: http://www.wseas.us/elibrary/conferences/2012/Algarve/ENS/ENS-17.pdf

Gupta, K., Kumar, P., Pathan, S.K. ,. Sharma, K.P. 2012. Urban Neighborhood Green Index – A measure of green spaces in urban. Landscape and Urban Planning, 105, pp. 325-335.

Kienast, F., Degenhardt, B., Weilenmann, B., Wäger, Y., Buchecker, M. 2012. GIS-assisted mapping of landscape suitability for nearby recreation. Landscape and Urban Planning, 105, pp. 385-399.

Kong, F., Nakagoshi, N., 2006. *Spatial-temporal gradient analysis of urban green spaces in Jinan, China.* Landscape and Urban Planning, 78, pp. 147-164.

Li, F., Liu, X., Hu, D., Wang, R., Yang, W., Li, D., Zhao, D., 2009. *Measurement indicators and an evaluation approach for assessing urban sustainable development: A case study for China's Jining City*. Landscape and Urban Planning, 90, pp. 134-142.

Lassen, M.S., Panagopoulos, T., 2008. Environmental awareness at the protected area of Brilhante, Brazil. International Journal of Energy and Environment, 2, pp. 1-8.

Jankovska, I., Straupe, I., Panagopoulos, T., 2010. Professional's awareness in promotion of conservation and management of urban forests as green infrastructure of Riga, Latvia. WSEAS Transactions on Environment and Development, 6(8), pp. 614-623.

Matsuoka, R.H., Kaplan, R., 2008. *People needs in the urban landscape: Analysis of Landscape And Urban Planning contributions.* Landscape and Urban Planning, 84, pp. 7-19.

Noronha Vaz, Eric de, Nijkamp, P., Painho, M., Caetano, M.. (2012). *A multi-scenario forecast of urban change: A study on urban growth in the Algarve Original Research Article*. Landscape and Urban Planning, 104, pp. 201-211.

Oh, K., Jeong, Y., Lee, D., Lee, W., Choi, J., 2005. Determining development density using the Urban Carrying Capacity Assessment System. Landscape and Urban Planning, 73, pp. 1-15.

Ong, B.L., 2003. Green plot ratio: an ecological measure for architecture and urban planning. Landscape and Urban Planning, 63, pp. 197-211.

Panagopoulos, T., 2009. Linking forestry, sustainability and aesthetics. Ecological Economics. 68, pp: 2485-2489.

Panagopoulos, T. 2012. The role of soil properties variability to reclamation success on the lignite strip-mined land in Northern Greece. Spatial and Organizational Dynamics, 9:43-59.

Papangelis, G., Tombrou, M., Dandou, A., Kontos, T. 2012. An urban "green planning" approach utilizing the Weather Research and Forecasting (WRF) modeling system. A case study of Athens, Greece. Landscape and Urban Planning, 105, pp. 174-183.

Petrov, L.O., Lavalle, C., Kasanko, M., 2009. *Urban land use scenarios for a tourist region in Europe: Applying the MOLAND model to Algarve, Portugal*. Landscape and Urban Planning, 92, pp. 10-23.

Ryan, R.L., 2011. The social landscape of planning: Integrating social and perceptual research with spatial planning information. Landscape and Urban Planning, 100, pp. 361-363.

Sandström, U.G., Angelstam, P., Khakee, A., 2006. Urban comprehensive planning – identifying barriers for the maintenance of functional habitat networks. Landscape and Urban Planning, 75, pp. 43-57.

Stephenson, J. 2008. The Cultural Values Model: An integrated approach to values in landscapes. Landscape and Urban Planning, 84, pp. 127-139.

Tyrväinen, L., Mäkinenn, K., Schipperijn, J. 2007. *Tools for mapping social values of urban woodlands and other green areas*. Landscape and Urban Planning, 79, pp. 5-19.

Willemen, L., et al. 2008. Spatial characterization of landscape functions Original Research Article. Landscape and Urban Planning, 88, pp. 34-43.

Xiaolu Zhou, Yi-Chen Wang, 2011. *Spatial–temporal dynamics of urban green space in response to rapid urbanization and greening policies*. Landscape and Urban Planning, 100, pp. 268-277.