Green space in urban areas: a methodological approach based on ecosystem services

EXTENDED ABSTRACT

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ABSTRACT

Green spaces in urban areas provide multiple and diverse functions like the contribution to the preservation of biodiversity, the rapprochement of the nature to the population, promoting this way the health and well-being. The aim of this study is to develop a methodological approach that provides a basis for planning and management of urban green spaces in order to identify the goods and services that urban green spaces can provide to the urban areas and their citizens. The proposed methodology consists on a set of criteria that express the goods and ecosystem services - local climate regulation, recreation, economic valuation of goods and services, citizen involvement in local planning and management, etc. - and their indicators to make possible its operation. The application of the indicators in urban park of Quinta das Conchas and Lilases makes possible an operationalization of the developed methodology. After the application of the indicators, the results are collected in the matrix which expresses the actual condition of each good and service, systematizing information that makes possible support decisions about the need for action in each urban green space analyzed.

1. INTRODUCTION

As urbanisation becomes increasingly prevalent, it is forecast that in 2030 more than 60% of the population will be living in cities (ONU, 2010). At the current time, cities occupy only 2.7% of the Earth's surface (ONU, 2010), but are responsible for 75% of total energy consumption, 80% of greenhouse gas emissions and have generically had a harmful effect on natural resources (Grimm et al., 2008; Grêt-Regamey et al., 2013) . The fragmentation and loss of habitats, the disturbance of the water cycle and the increase in the urban heat island effect are characteristic processes in present-day cities (Alberti, 2005; Liu et al., 2007; Marzluff et al., 2008; Endlicher et al., 2008). In this context, there is an evident need to guarantee the preservation of natural systems in urban areas and to contradict the gradual loss of contact with nature, particularly bearing in mind that, paradoxically, cities also require ever-increasing natural resources – food, energy and raw materials (Grêt-Regamey et al., 2013). In light of this reality, ensuring compatibility between natural and built systems has become one of the greatest challenges of the 21st century.

Green spaces in urban settings perform multiple and diverse functions, from contributing to the preservation of biodiversity, to supplying food, regulating the water cycle, promoting adaptive responses to climate change and, additionally, bringing the population closer to nature and promoting health and well-being, awareness and environmental education. Associated with this series of functions, urban green spaces, according to Young (2010) are high in ecological, economic and social value since they are important focal points in the provision of ecosystem goods and services in an urban setting (Bolund et al., 1999; Grêt-Regamey et al., 2012). Ecosystem goods and services make a decisive contribution to promoting public health and improving people's quality of life (Bolund et al., 1999). In this work, the concept of ecosystem goods and services is defined as being the direct and indirect benefits that people obtain from urban green spaces (e.g. pollenisation, purification of water, noise reduction, rainwater drainage, food supplies and aesthetic benefits).

Larondelle et al. (2012) mention that despite there being no spatial pattern in the ecosystem goods and services offered, there are certain goods and services (e.g. regulation of local climate) that are provided more efficiently within city limits (at local scale). It is in this sense that the concept of ecosystem goods and service arises as an opportunity in the definition of a methodological approach capable of supporting decisions on the planning of green spaces in urban settings, as well as their subsequent management with a view to taking the best possible advantage of their potential (Szumacher, 2011).

The main goal of this work, therefore, is to develop a methodological approach that serves as a basis for the planning and management of urban green spaces, in order to identify the goods and services that these spaces can supply to urban areas and their inhabitants. This proposal comprises a series of criteria that express the ecosystem goods and services and respective indicators with a view to making their implementation possible. This methodological approach is exemplified by means of

methodological testing conducted in an urban park, which served as support for the subsequent refining of the indicators.

This dissertation comprises six chapters, which correspond to the various stages in the study. In the first stage (Chapter Two), a theoretical analysis was undertaken of the evolution of the role of urban green spaces, their functions, uses and benefits, and most common types. The second stage (Chapter Three) contains the presentation of the methodological approach; the ecosystem functions and services of urban green spaces were determined (e.g. regulation, support, information, supply and integration) by identifying a series of criteria and indicators. This was followed by a methodological test in the Quinta das Conchas e dos Lilases Urban Park, with a view to validating the proposed methodology (Chapter Four). Lastly, in Chapter Five, the results of the application of the methodology are presented in a synthesis matrix, showing the current condition of each of the goods and services provided by the green space under analysis, and where the strengths and weaknesses of the proposed methodological approach for supporting the planning and management of urban green spaces are discussed.

2. URBAN GREEN SPACES – CONCEPT, FUNCTIONS AND TYPOLOGIES

The concept of green space has taken different forms over time and according to urban conceptions that are associated. In fact, this concept is as old as the city itself. However, the concept of urban green spaces as it is understood nowadays appears basically from the nineteenth century (Jim et al., 2002; Fadigas, 1993; Telles, 1997). This concept is no more exclusively associated with space of socialization for the dominant classes (Magalhães, 1992; Salgueiro, 2005), and starts to be perceived as a space able to integrate the principles that today could be described as "environmental" in densely built-up areas.

In the 1980s, with the emergence of the concept of sustainable development are also introduced in urban planning several ecological concepts centred in landscape ecology (Jim et al., 2003) which suggest that, at the regional scale, the optimal configuration of the landscape is the development of urban areas ("city patches") inserted inside a green matrix ("greenspace matrix") with several habitats and ensuring their "connectivity", based on a framework of ecological corridors (Jim et al., 2003). In fact, one of the main problems associated with loss of biodiversity in urban areas, apart from reduction of number and area of habitats, is its fragmentation (e.g., Forman, 1995; Bennett, 1999; Hess et al. 2001; Turner et al. 2,001; Ahern, 2003, 2007; Opdam, 2006). Since then, the consequence of growing concerns about environmental issues (Kabisch et al., 2012), has been reflected in the increasing number of green spaces in several European cities.

With the recognition of urban green spaces as part of the city (Dunnett et al., 2002) is essential for decision makers to identify and understand the structure (James et al., 2009), interactions, functions

and benefits that take place and provide these spaces. However, their functions are multiple and depend on your location in the city and its relationship with the built space.

In the literature, urban green spaces has already been worked out in various ways and grouped according to the functions they perform in three domains: environmental, economic and social (e.g., Burgess et al., 1988; Morgenstern, 1999, Jim, 2004; Boone et al. 2,009; Chiesura, 2004; Wendel et al. 2,011; Swanwick et al. 2,003; Tzoulas et al. 2,007; Alberti, 2005, Taylor et al. 2,001, Stephen et al. 1995).

Urban green spaces have varied properties and dimensions and offer much diversified uses and functions. Swanwick et al. (2003) highlights the difficulty to acquire up a clear view of the full diversity of green spaces that currently exist in urban areas, which is reflected in the lack of consistency of definitions, in the risk of redundancy with the identification of green spaces and even, the lack of compatibility between different local authorities.

3. METHODOLOGICAL APPROACH BASED ON ECOSYSTEM SERVICES

The concept of ecosystem services has a long history, and has being used since 1970. However its importance increeses only after 1990, with the publication of "The value of the world's ecosystem services and natural capital" by Costanza et al. 1997 (De Groot et al. 2010). This concept has given a new direction to the discourse on the preservation and appreciation of the benefits provided by ecosystems for the human beings (e.g., Daily, 1997; Costanza et al, 1997; De Groot, et al, 2002; MEA, 2005) and presents an opportunity to build a methodology as a basis for the creation and use of indicators of urban green spaces.

In this study, the concept of ecosystem services aims to be useful to the development of a methodology able to identify both the services provided by urban green spaces either the multiple effects that any change might have on these spaces.

It is consensually recognized the difficulty in identifying the goods and services provided by ecosystems and this difficulty is more emphasized in urban green spaces scale. Despite this difficult, the large concentration of the majority of the population in cities also depends on the goods and services provided by green spaces (Gret-Regamey, et al., 2012; Larondelle, et al., 2012). However, many authors have identified the need for better understanding of ecosystem services provided by urban green spaces, so as to incorporate this concept in a process of planning and management of urban green spaces (Yli-Pelkonen et al., 2005; Larondelle, et al., 2012).

The aim of this study is to identify the functions, but also the goods and ecosystem services provided by urban green spaces as an opportunity to define a methodology of planning and valuation of urban green spaces.

The set up of a methodological approach works as a basis for the planning and management of urban green spaces and requires the identification of a set of criteria for each function performed by these spaces (regulation, support, information, provisioning and integration).In this methodology each criteria represents a particular good or service offered by urban green spaces. However, taking into account the aims of this study, for the identification of the criteria, not only the ecosystem services provided by urban green spaces (eg provision of food, regulation of erosion, promotion of social interaction), but also the primary conditions necessary to the provision of these goods and services (eg presence of water features; sustainable technology) was considered. In its turn, for each criteria an association of one or more indicators was needed to identify and quantify the availability of services in a given urban green space.

The operationalization of indicators presumed the collection and processing of several types of information: (a) the on-site observation, (b) the collection of data through interviews with experts and institutions responsible for planning and management of green spaces, (c) conducting user surveys of the area under study, and (d) the mapping the indicators in a Geographic Information System (GIS).

4. CASE-STUDY AND METHODOLOGICAL OPTIONS

The Urban Park of Quinta das Conchas e dos Lilases (approximately 24 ha) is located in the village of Lumiar, more precisely in Alameda das Linhas de Torres. This park is the third largest green space in the north of Lisbon, followed the Urban Park of Monsanto (900 ha) and the Parque da Bela Vista (85 ha) (Marques, 2011).

The choice of the urban park of Quinta das Conchas e dos Lilases as object of study is mainly due to the heterogeneity that characterizes this park, where the existence of three areas with ecological characteristics, functional and aesthetic totally different can be recognized - Quinta dos Lilases, Nave Central and Mata. This diversity is helpful to test the proposed approach under different scenarios. Through the analysis of the applicability of the methodological approach in a specific context is possible to obtain a more accurate knowledge about the possibility of operationalization of a set of indicators "theoretically desirable".

It is important to mention that due to the large number of indicators collected and the difficulty in obtaining both cartographic data in digital format (especially at a scale greater detail) or statistical makes impossible the operationalization of all indicators.

In order to illustrate the operationalisation of the indicators, the density tree coverage indicator associated with the local climate regulation criteria was selected.

Urban park area			Number subjects (richness numeric)	Density tree coverage indicator (nº species/area)
	Area(ha)	Area (m2)		
Nave Central	9.3608	93608	1107	1.183
Mata	10.6163	106163	2258	2.127
Parque dos Lilases	4	40248	Information not provide	Information not provide

The methodology used in quantifying the indicator density tree cover, which is a proxy of the local climate regulation, was calculated as the ratio between the actual number of trees in the park and the total area of the park in ha/m2. The selection of this method to quantify the density tree cover indicator is due to the missing data on treetop information, and the impossibility to obtain these data.

Based on the information collected about vegetation was possible to map the tree coverage density indicator (figure 1) through the tool point density estimation method.
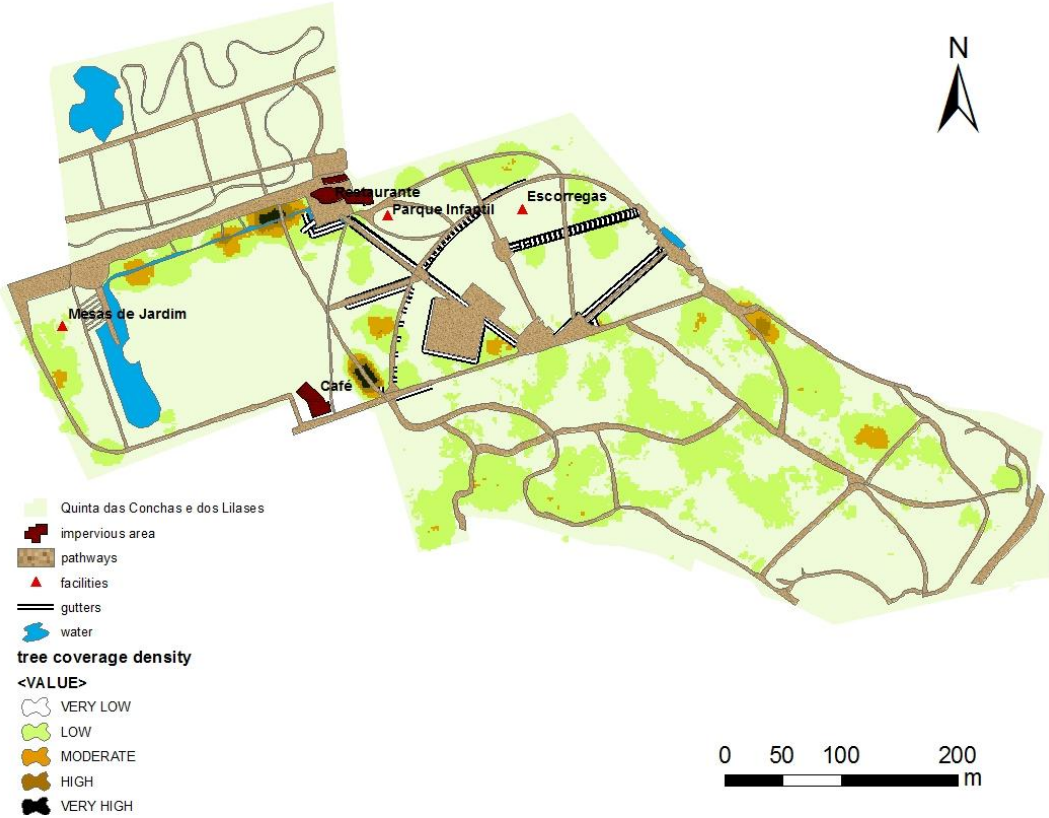

Figure 1: Tree coverage density indicator

The results after assessing the current condition of the goods and services provided by the three areas of the park are assembled in a matrix which expresses the current condition of each good and service in the green space analysis.

5. DISCUSSION AND CONCLUSION

The construction of the methodological approach presented here consisted in the identification of a series of criteria for each function performed by urban green spaces (regulation, support, information, supply and integration). Each criterion represents specific goods or services provided by urban green spaces. It should be particularly noted that, for the purposes of identifying the criteria, not only were the ecosystem services made available directly by the urban green spaces taken into consideration (e.g. supplying food, regulation of erosion and promotion of social interaction), but also the primary conditions needed to enable these same goods and services to be provided (e.g. the presence of water and sustainable technology). In turn, each criterion was associated to one or more indicators that would make it possible to identify and quantify the availability of the services in a given urban green space.

By applying the indicators at the Quinta das Conchas e dos Lilases Urban Park, it was possible to test the operating capacity of the methodology developed.

Thus, after initially identifying the ecosystem functions performed by the urban green spaces, the services to be supplied were determined and the respective set of indicators enabling operationalisation was defined. These last two are both shown on a synthesis matrix allowing the availability of the services in each area of the park to be understood. The results set forth in the matrix, thus express the current condition of each of the individual goods and services, systematising information capable of supporting decision-making in respect of the need for intervention in each urban green space analysed.

For the purpose of analysing the results obtained, a classification system was defined, consisting of only two categories: present and absent. The category "present" indicates that the area under analysis provides the service, whereas the category "absent" indicates that the service is not provided.

Contrary to what happens with the criteria (ecosystem services), it is not necessary to collect all the indicators. However, when using more than one indicator to determine the condition of the services available, as is the case with social and economic services, it was established that only in the event of there being positive results in relation to more than one indicator, would the presence of this service be assumed; otherwise, it would be classed under the "absent" category.

It can be seen that the pattern of goods and services offered, whether ecological, social, economic or institutional, is determined essentially by the physical and functional characteristics of each green area, notwithstanding the importance of the time variable. For example, reading the matrix in conjunction with the results of the indicators, it can be concluded that despite the fact that the three

distinct areas into which the park is divided all provide the service of local climate regulation, the Mata (forest) section, due precisely to its physical and functional characteristics, has a denser tree coverage than both the Nave Central (central section) and the Parque (parkland) section, and thus is more suited to providing this service. Similarly, the diversified structure of the Nave Central means that this section is suited to providing a greater number of goods and services, both ecological (alternating areas of lawns and trees) and social and economic. The synthesis matrix should ideally be consulted in conjunction with the results of the indicators, since this makes it possible to see which of the three green areas has the greatest capacity to provide a larger number of goods and services.

The basis for the methodological approach proposed was the concept of ecosystem services, due to the potential of this concept which, since it centres on results, makes it possible to evidence services that can only be generated by integrating ecological, social, economic and institutional aspects, in addition to enabling complementarities between the services provided in various domains to be demonstrated.

However, the classification system proposed does have limitations insofar as it does not enable a reading of the stock to be made, or, more precisely, of the capacity of a green space to provide a given service, i.e. to make a comparison between the service actually provided and the maximum potential to provide it. This limitation is due to the fact that the supplying of each service depends on the green space's physical characteristics and on its cultural context. As such, identifying the maximum potential, or the optimal value of provision of a given service, would require research to be undertaken which would enable information to be gathered to refine the classification system, but also enable this methodological approach to be transformed into a tool for assessing urban green spaces and the subsequent development of a standard (benchmark) allowing comparisons to be made in the performance of distinct green areas and, ultimately, to test alternative management models.

Recognising the role of urban green spaces as the main moderator (or interface) in the relationship between the natural environment and the built environment (Young, 2010), in this dissertation the need for greater comprehension of the services provided by these spaces was identified. In fact, it is essential to set aside the view of planning and management of green spaces that only takes into account the "traditional" services, and to adopt a more comprehensive view that acknowledges the value of other functions which respond to emerging social demands.

REFERENCES

AHERN, J.F. (2002). Greenways as strategic landscape planning: Theory and Application. Doctoral thesis. Department of Physical Planning and Rural Development. Wageningen University, The Netherlands.

ALBERTI, M. (2005). The effects of urban patterns on ecosystem functioning. International Regional Science Review, 28(2), 168-192.

BOLUND, P., & HUNHAMMAR, S. (1999). Ecosystem Services in urban areas. Ecological economics, 29, 293–301.

ENDLICHER, W.; JENDRITZKY, G.; FISCHER, J.; REDLICH, J.P. (2008). Heat Waves, Urban Climate and Human Health. J.M. Marzluff et al. (eds) Urban Ecology (pp.269-278), Berlin: Springer.

GRÊT-REGAMEY, A., & ULRIKE, W. (2012). Multi-criteria decision analysis for planning and design of sustainable energy landscapes. Sustainable Energy Landscapes: Designing, Planning, and Development, 111-132.

GRÊT-REGAMEY, A.; CELIO, E.; KLEIN, T.; M.; HAYEK, U.W. (2013). Understanding ecosystem services trade-offs with interactive procedural modeling for sustainable urban planning. Landscape and Urban Planning, 109 (1), 107-116.

LARONDELLE, N., & HASSE, D. (2012). Valuing post-mining landscapes using an ecosystem services approach — An example from Germany. Ecological Indicators, 18, 567-574.

LIU, G.C.; WILSON J.S.; YING J. (2007). Green neighbourhoods, food retail and Childhood overweight: differences by population density. American journal of Health promotion, 21(4), 317-325.

LIU, J.; DAILY G.C.; EHRLICH P.R.; LUCK G.W. (2003). Effects of household dynamics on resource consumption and biodiversity. Nature, 421, 530–533.

YOUNG, R. (2010). Managing municipal green space for ecosystem services. Urban Forestry and Urban Greening, 313-321..