



Relationships among satisfaction, noise perception, and use of urban green spaces



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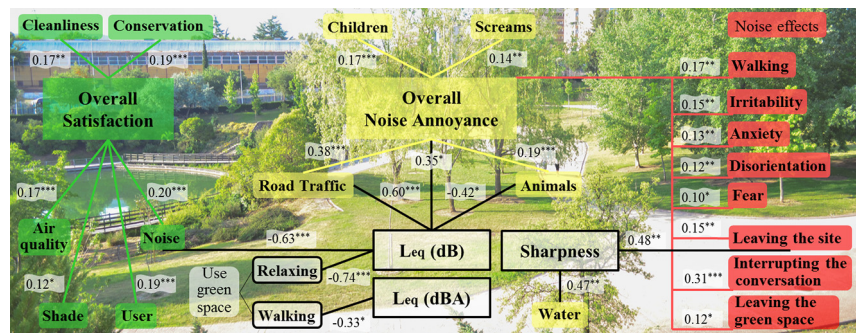
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HIGHLIGHTS

- Noise is the most influential factor in the evaluation of an urban green space.
- Road traffic remains the fundamental source of noise in urban green spaces.
- For the same sound level, noise annoyance is lower than in other urban areas.
- L_{eq} (dB) and sharpness proved to be good estimators of noise perception.
- The lower the noise, the higher the frequency of relaxation and walking activities.

GRAPHICAL ABSTRACT



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ABSTRACT

Nowadays, urban design without green spaces is inconceivable. Environmental, social, and economic benefits generated by green spaces are essential to maintain the health and quality of life of the population and to control pollution. Therefore, urban planners and city leaders should know the interactions between the features of green spaces, the sociodemographic characteristics of users, and the type of use. In addition, in some studies, noise was found to be an essential factor in the perception of these green spaces. For this purpose, surveys and sound measurements were carried out simultaneously in different locations of the main green spaces of Cáceres city. The results of this study show that noise satisfaction has the greatest significant relationship with overall satisfaction with green spaces. Different features, including satisfaction with the absence of noise, can explain 71.4% of the overall satisfaction. Road traffic is the most annoying sound source, but the degree of noise annoyance is lower than that estimated for other urban environments with similar sound levels. Walking and talking activities, emotions of fear and irritability, and interruptions to conversation are most often affected by noise in these urban environments. Another conclusion obtained is that the highest significant correlation coefficients are between noise perception by users and both the equivalent continuous linear weighted sound level and sharpness. Lastly, the green-space use determines differences and significant relationships with the sociodemographic characteristics. Also, the places in green spaces where people frequently perform walking and relaxation activities have the lowest sound levels. Therefore, noise is a statistically relevant factor to be considered in the design of green spaces.

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1. Introduction

In the last decades, there has been a clear trend toward the depopulation of rural areas and increasing concentration of human beings in

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cities. Currently 57% of the population live in agglomerations having populations in excess of 300,000 people, and it is estimated that by the year 2030, 62% of the global population will live in cities (UN, 2014).

The rapid growth of cities has brought social, economic, and environmental challenges (EC, 2000). Five objectives in the environmental dimension have been defined for a European vision of tomorrow's cities: mitigate and adapt to climate change; protect, restore, and enhance biodiversity and ecosystems; reduce pollution; manage natural materials resources sustainably and prevent waste; and protect, preserve, and manage water resources (RFSC, 2016). Populations are living in environments with increasing pollution, intense heat, habitat loss, declining biodiversity, and noise (EEA, 2014, 2016; IEAGHG, 2016; RFSC, 2016). Approximately seven million people died in 2012 due to exposure to air pollution (WHO, 2014), and 60,000 disability-adjusted life years are lost through ischaemic heart disease due to environmental noise (WHO, 2011). There is a critical need to find ways to reduce health risks and improve the wellbeing of citizens.

Studies from numerous fields have analysed the benefits provided by urban green spaces in cities and they are related with three key values: social, economic, and environmental (Chiesura, 2011; Sander, 2015; Scopelliti et al., 2016; Szeremeta and Zannin, 2013). Urban green spaces play an important role from a social perspective by promoting physical activity, allowing rest or relaxation and increasing social interaction (Dadvand et al., 2016; Kaczynski et al., 2008; Maas et al., 2009; Peters et al., 2010). They therefore help to facilitate active lifestyles and emotions of restoration while reducing stress and social isolation in urban environments (Coombes et al., 2010; Grahn and Stigsdotter, 2003, 2010; Jay and Schraml, 2009). Urban green spaces also benefit local residents and communities economically. Aesthetic and recreational values of urban green spaces increase the attractiveness of a city and promote it as a tourist destination, thus generating employment and revenue (Jim and Chen, 2006). Water and vegetation also increase property values (Luttik, 2000; Sander and Haight, 2012). The other key value of urban green spaces is environmental benefits, such as counteracting the urban heat island effect (Doick et al., 2014; Feyisa et al., 2014), reducing air pollution (Cohen et al., 2014; Yin et al., 2011), mitigating runoff (Xiao et al., 1998), and maintaining urban biodiversity (Alvey, 2006; Paker et al., 2014). Consequently, due to the range of social and environmental services they afford, urban green spaces are a public good and their availability is a core indicator for a sustainability profile (EC, 2000).

Noise pollution ranks second among a series of environmental stressors in terms of public health impacts (WHO, 2011). The existence of "quiet areas" is among the objectives of the European noise policy (EC, 2002). However, some studies show that noise levels in urban green spaces are not significantly lower than those in the typical home environment (Cohen et al., 2014; Martínez Suárez and Moreno Jiménez, 2013; Lam et al., 2005; Tse et al., 2012; Zannin et al., 2006).

Urban green space functionality and outcomes are closely related to their features (Dzhambov and Dimitrova, 2015). Recent studies relate some features or uses of urban green spaces to the benefits they provide (Dadvand et al., 2016; Scopelliti et al., 2016). However, studies analyzing the relative contributions of the different features of green spaces to the overall explanation of their functionality remain scarce.

In this study, the features of green spaces were evaluated through the perceptions of users and, from these perceptions, their relationships with respect to the overall satisfaction with the green areas were analysed. The extent to which a user takes into account the features of a green space when giving it an overall assessment is a very important aspect for urban planners and city leaders. Thus, core indicators for a local sustainability profile were evaluated: availability of local public green areas and citizens' satisfaction with the local community (EC, 2000).

Because of the importance of noise satisfaction in the overall assessment of green areas, another objective of the study was to analyse the

annoyance caused by noise sources and their effects on users' activities and attitudes.

Finally, satisfaction with the features of green spaces, the annoyance caused by noise, and the effects of noise were related to the sociodemographic characteristics of the users. In addition, the relationship between these aspects and the activities carried out by users in urban green spaces was analysed. These results could also be used by urban planners when designing green spaces for certain uses.

2. Methodology

2.1. Study area

The study was carried out in green spaces of Cáceres, a medium-sized city located in the southwest of Spain, whose proportion of green area per inhabitant is approximately 16.6 m² per inhabitant. This proportion is one of the highest in the country and is greater than the range of 10–15 m² per inhabitant recommended by the World Health Organization (Brebba et al., 2010).

The following urban green areas were selected for this study: Cánovas, Principe, Valhondo, Fernando Turégano, Fray Pacífico, Perú, and Rodeo. Locations and aerial photos of the green spaces are shown in Fig. 1. The green spaces were chosen on the basis of location, size, and year of inauguration (see Table 1).

These green spaces are located in densely populated urban areas and are representative of the different districts. They are popular green spaces frequently visited by citizens in Cáceres. The selected green spaces were large enough for the activities analysed later in the survey. The age of the green spaces made it possible to analyse the evolution of satisfaction regarding the features evaluated in previous studies.

2.2. Surveys

A cross-sectional study was carried out during 2014 by means of questionnaires administered during daytime to a random sample of adult visitors to the seven urban green spaces selected. Face-to-face interviews were conducted by trained interviewers. During the survey, respondents were informed about the objectives of the study and the time required to complete the questionnaire (about 10 min). A total of 182 completed questionnaires were used for this study. The percentage of respondents compared to the total number of citizens was similar to that used in recent studies (Dzhambov and Dimitrova, 2015; Kaczynski et al., 2008) with a sufficient statistical power (Fritz and Mackinnon, 2007). The questionnaires were well distributed in terms of district, sampling points, size of green space, and number of visitors. In this way, the sample presented sociodemographic characteristics representative of the population resident in Cáceres (see Table 2).

In each urban green space, the sites most frequented by visitors were selected to conduct the surveys and the acoustic measurements (see Fig. 1). Interviews and acoustics measurements were carried out simultaneously.

In the survey, three dimensions were analysed: satisfaction (12 items, $\alpha_{\text{Cronbach}} = 0.79$), noise annoyance (8 items, $\alpha_{\text{Cronbach}} = 0.70$), and effects of noise (14 items, $\alpha_{\text{Cronbach}} = 0.81$). The items were rated on a five-point Likert scale ranging from 0 ("not at all" or "never") to 4 ("a lot" or "very often").

In the first dimension, the satisfaction with the features of urban green spaces was analysed. The following items were evaluated: cleanliness, air quality, noise, aesthetics, safety, users, conservation, location, size, groves, and shade. These features were selected due to their relationship with social, economic, or environmental aspects that influence the overall satisfaction with green spaces. Overall satisfaction was also evaluated in one item. The cleanliness, aesthetics, and conservation along with environmental features such as groves have an influence on the visual assessment of the green space. In turn, these features influence the overall valuation and can influence the valuation of other

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