MADRID
inter.noise 2019
June 16 - 19
NOISE CONTROL FOR A BETTER ENVIRONMENT

Effects of noise on the streets and urban planning

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ABSTRACT

The presence of different sounds sources in urban environments, their number and their relative importance are closely related to temporal and spatial aspects and to the urban structure. Therefore, all these sources generate a sound environment with a dependence on the place and the time where listeners are. This sound environment is in many cases a reason of discomfort and it has negative effects on the health and quality of life of the people exposed to it. Focusing on this area, the effects of the sound environment on the perception of people who walks through

the streets of a small city are studied in the present work and this perception is related to urbanism.

Keywords: Soundscape, urban planning, traffic noise, sound perception**.**
I-INCE Classification of Subject Number: 61

1. INTRODUCTION

In recent years, the control of noise pollution has become an increasingly important objective for urban planners. Many studies focus on the negative consequences of noise on people's health, showing that it can have a wide range of effects on humans, including cardiovascular problems, sleep disturbances, cognitive impairment, hearing diseases, stress and even diabetes [1-4].

The perception of the different sound sources present in cities depends largely on spatial and temporal aspects [5]. Therefore, urbanism and architecture can play a relevant role in people's perception of the sound environment. It is therefore interesting to study whether the characteristics and urban functionality related to buildings, the typology of streets [6], the presence of green environments [7], etc., influence the final assessment of the urban environment under consideration, including the acoustic component as a part of an interdisciplinary approach [8-10].

This research arises from the need to complement the traditional methods of measuring sound levels [11,12] with studies related to the perception of the environment [13,14]. In this way, the urban environments can be known in a more complete way, establishing relations not only between the noise doses received and between the effects induced into the population [15]. Thus, other subjective aspects perceived by people as well as the urban characteristics of the surroundings are integrated into the studies.

2. METHODOLOGY

This work has been carried out in different streets of the city of Cáceres (Spain), taking as the basis of the sampling the Method of Categorization proposed by Barrigón et al. [16,17]. We have chosen 12 streets of category 1, 2 and 3 that, according to the described method, are those that serve to communicate the city with other national and regional zones and that give access to the zones of interest or to the most important distribution nodes of the city. Because the study is mainly perceptive, a process of surveying passers-by in the chosen areas has been carried out (Fig.1).

For the analysis of the perception of the characteristics of the environments, a survey on the perception of the sound environment has been developed, using a Likert scale with a range of 0 to 6, where 0 is nothing and 6 is a lot. These questionnaires arise as an evolution of previous ones that the research team of the Acoustics Laboratory of the University of Extremadura has used in different works over the last few years [5,18,19].

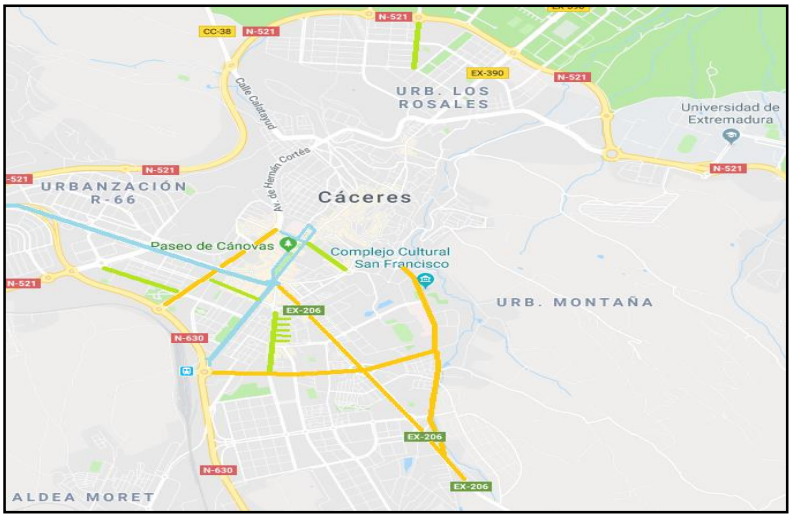

Figure 1. *Selected streets in Cáceres for the study. In blue those of category 1, in orange those of category 2 and in green those of category 3.*

The survey evaluates urban characteristics by analysing the overall assessment of the environment, as well as the assessment of different specific environmental characteristics. In particular, cleanliness, air quality, sounds, smells and aesthetics were considered to be of interest. Finally, the survey also collects some sociological data from those surveyed.

An analysis has been carried out relating the citizen's perception of the environmental characteristics indicated with different urban characteristics of the places in which the study was carried out. In particular, the following urban characteristics have been considered: space of green areas, width and length of streets, average height of buildings and resident population.

One hundred twenty surveys have been carried out for this study. For the treatment and analysis of the information, the average values of the valuations of the environmental characteristics were obtained for each of the 12 chosen streets. The age range and sex of the sample are in accordance with data from the National Statistics Institute [20]. Thus, 56% of women and 44% of men between the ages of 15 and 100 collaborated in the study, with the ranges of 15 to 25 years and 25 to 45 years being the ones that participated the most in the survey.

3. RESULTS

Firstly, the average valuations obtained by the urban environments studied or the environmental characteristics existing in them will be analysed. Those surveyed agree in giving an above-average rating to the overall situation of the environments. With respect to the environmental characteristics, it has been observed how cleanliness, air quality, odours and the aesthetics of the environments are evaluated in a positive way, with values in the range of 3.5 to 4.5. On the other hand, sounds obtain an average score of less than 3.0 points. This is the only environmental characteristic in that circumstance, which means that it is the worst rated of all those studied (Fig.2).

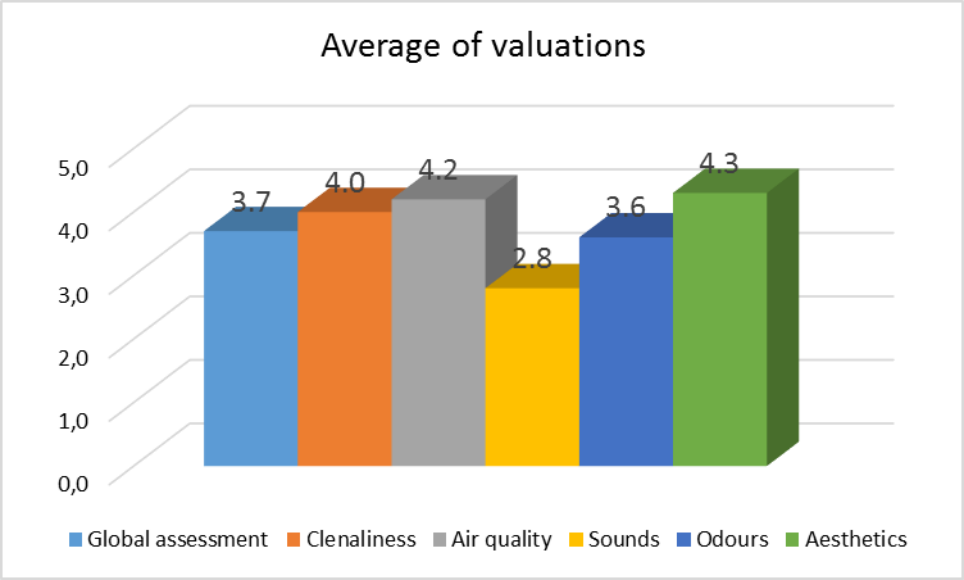

Figure 2. *Average valuation of affective aspects.*

Later, an analysis was carried out, using Spearman's rho, of the possible existing relations between the subjective variables (related to the assessment of the environmental and general characteristics of the environments studied) and their objective urban characteristics (Table 1). Given that this study has not found any relationship with the width, length, population and average height of the streets, these characteristics have been excluded from this analysis.

Table 1. *Correlation coefficient using Spearman's rho*

	Subjetive					Objetive
	Cleaning	Air	Sound	Smell	Aesthetic	Green area
Global	$0.11^{n.s.}$	$0.32^{n.s.}$	0.62^{*}	0.83^{**}	$0.17^{n.s.}$	$0.13^{n.s.}$
Cleaning		0.70^{*}	$0.16^{n.s.}$	$0.12^{n.s.}$	0.68^{*}	$0.03^{n.s.}$
Air			0.61^{*}	$0.19^{n.s.}$	0.64^{*}	$0.44^{n.s.}$
Sound				$0.28^{n.s.}$	$0.15^{n.s.}$	0.62^{*}
Smell					$0.46^{n.s.}$	$-0.18^{n.s.}$
Aesthetic						$-0.05^{n.s.}$

$^{n.s.}$ non-significant differences.
* p-value < 0.05.
** p-value < 0.01.

It can be observed in table 1 that, in this study, only a significant relationship has been found between the valuation given to sounds and the surface of green areas present in the places where the surveys were carried out. Figure 3 shows in detail the relationship found between these two variables. A positive relationship can be observed between the presence of green areas and the valuation given to the sounds of the surroundings, so that, as the surface of vegetation increases, the valuation of the sounds of the surroundings tends to be greater.

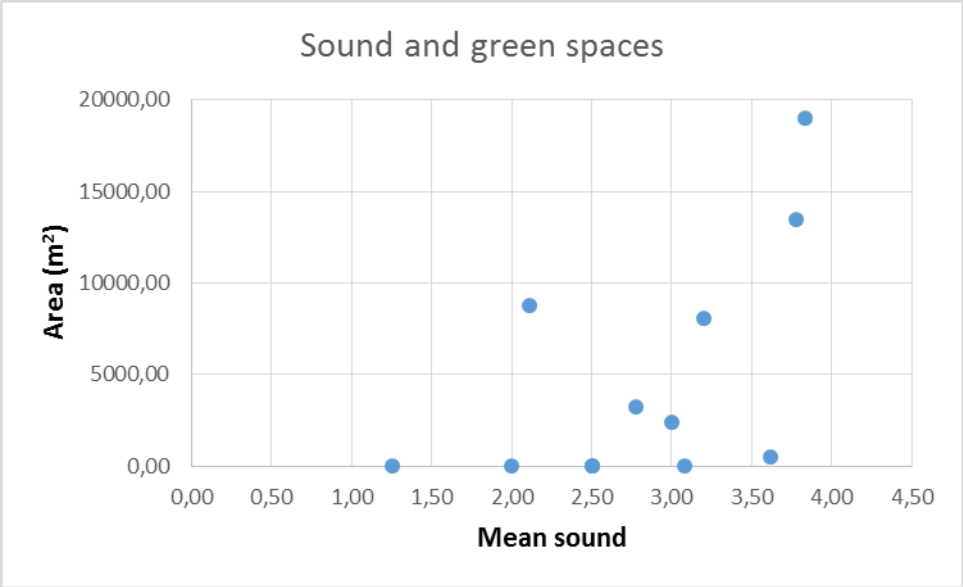

Figure 3. *Comparison of the average sound valuations with the surface of green areas in the places where the survey was conducted.*

Finally, by means of Spearman's rho, the possible interrelations that could take place between the same subjective variables. In other words, it has been analysed whether there are relationships between the general valuation of the environments studied and the valuation of the environmental characteristics or whether there are relationships between the valuations obtained for these characteristics.

It can be seen in table 1 how in this study both the assessment of the sound environment and the assessment of its olfactory characteristics have resulted in a significant relationship with the overall assessment of the environment. Note how, in both cases, the relationship between the variables is positive. By way of example, Figure 4 shows the detail of the relationship between the assessment of the sound environment and the overall assessment of the environment.

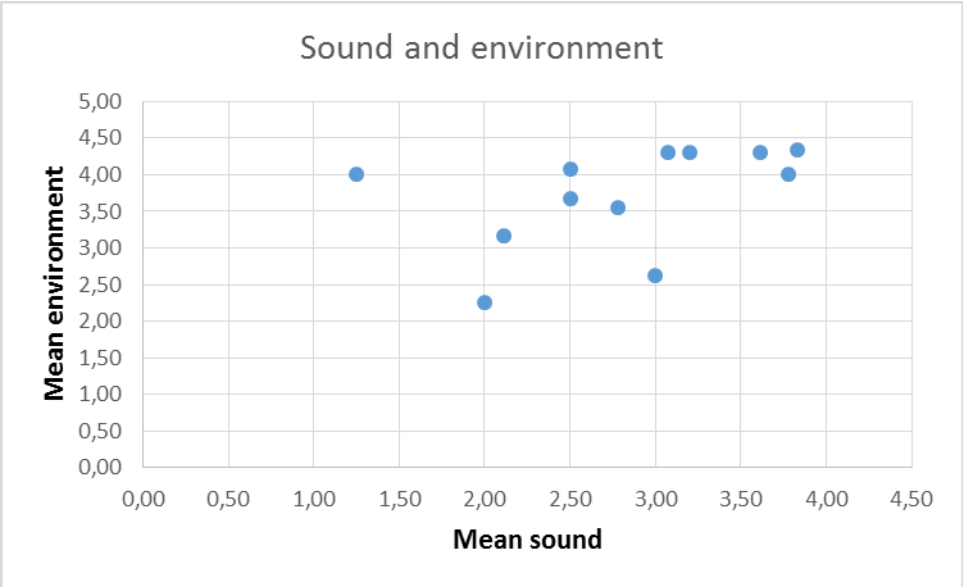

Figure 4*. Comparison of average sound ratings with overall average ratings at the locations where the survey was conducted.*

On the other hand, we can observe the existence of relations between the valuations assigned by those surveyed to some of the environmental characteristics of the environments studied (Table 1). It is observed how the perception of air quality is significantly and positively related to the assessment of other environmental characteristics, in particular with the sound environment, cleanliness and aesthetics of the environment. In addition, there is also a significant positive relationship between the latter two, aesthetics and cleanliness of the environment. By way of example, Figure 5 shows the detail of the relationship obtained between the assessment of the sound environment and the assessment of air quality.

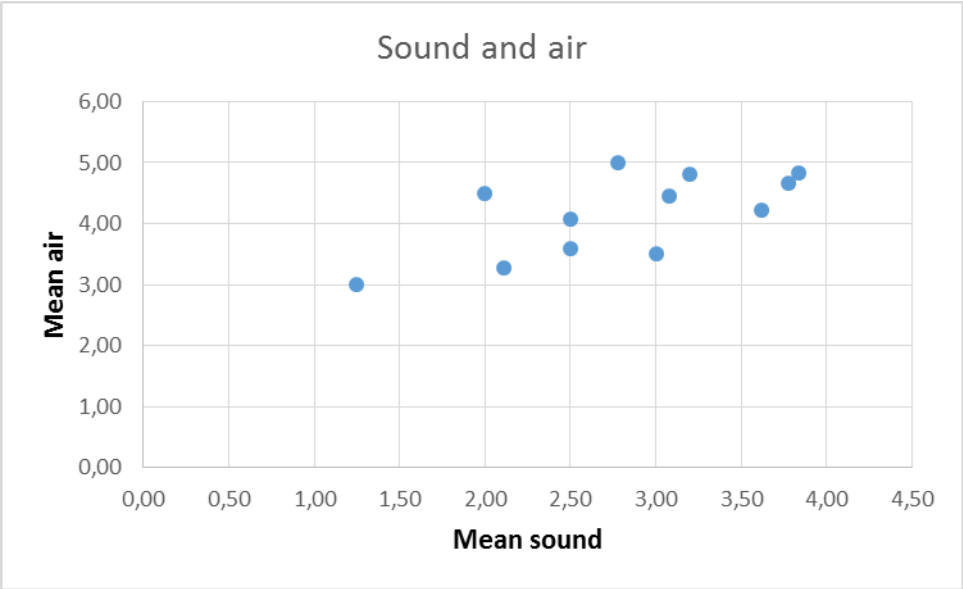

***Figure 5**. Comparison of the average sound ratings with the average air quality ratings in the locations where the survey was conducted.*

Therefore, when it comes to the evaluation of the sound environment, three statistically significant relationships have been found:

- Firstly, between the assessment of the sound environment and the surface of the green areas present, which is an objective urban characteristic. It has been obtained that the greater the surface of green zones, the better is the valuation of the sonorous environment of the streets.
- Secondly, between the assessment of the sound environment and the overall assessment of the environments. This suggests that the set of sounds heard by respondents influences the overall assessment of the streets.
- Finally, between the assessment of the sound environment and the assessment of air quality. The fact that the main source of air pollution in the areas assessed is road traffic may be influencing the relationship between these two characteristics assessed by users.

These results are similar to those obtained in previous research in urban green spaces or in quiet areas in the city of Cáceres by Rey Gozalo et al. [13,14], with the particularity that this analysis was made in the streets of Cáceres. The presence of near green areas, where the sound environment is most extensive, helps to improve the sound assessment of the streets.

4. CONCLUSIONS

In this research, an objective and subjective analysis of different features of categorized streets by the categorization method was carried out in the city of Cáceres.

The results obtained allow us to establish different relationships between some subjective features and the urbanistic characteristics of the city. The following conclusions can be drawn:

- The perception of the sound environments in the first three categories established by the Acoustic Laboratory of the University of Extremadura is clearly influenced by the presence of road traffic, qualifying the sound sensation of these environments generally in a negative way. This feature is the only one evaluated below the average of the 7 values Likert scale chosen.
- The presence of near green areas, where the sound environment may contain more pleasant elements such as bird trills or fountain sounds, can help to improve the sound assessment of the streets.
- The global assessment of an urban environment and the perception of the air quality can be influenced by the sound environment.

5. ACKNOWLEDGEMENTS

This work has been partially financed by project IB18050, Junta de Extremadura, Consejería de Economía e Infraestructura, GR18017; European Fund for Regional Development (ERDF), European Social Fund (ESF) and Comisión Nacional de Investigación Científica y Tecnológica (CONICYT) through project FONDECYT Nº 1180547). G. Rey-Gozalo is financed by Juan de la Cierva - Contract for the incorporation of the Ministerio de Economía, Industria y Competitividad (IJCI-2016-28923). David Montes González is supported by European Union, European Social Fund (ESF) and Consejería de Economía e Infraestructuras of Junta de Extremadura.

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