



Estimating leisure noise in Spanish cities



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ABSTRACT

Noise pollution is a great environmental problem in big cities. In particular, the leisure noise is one of the most significant problems during the night period and the responsible of a growing number of complaints and sleep disturbances from population.

For that reason, with the aim of approaching an analysis on spatio-temporal evolution of the leisure noise, some areas with leisure activity as main noise source was sampled. With these results, a protocol to address an appropriate action against leisure noise problems is put forth. This procedure explains how to diagnose a leisure area or predict the noise levels inside these areas. Therefore, the proposed procedure could help taking better solutions in order to reduce the impact of leisure noise on the exposed population.

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1. Introduction

During a long time the most important worry about leisure noise has been the high noise exposure of young people inside leisure places, and consequently, their hearing loss [1,2]. The leisure noise is present not only inside bars, pubs or discos, but also in streets, where young people usually do social activities or drink [3] in the called leisure areas. These areas are usually placed in residential zones, so not only young people are affected, but also neighbors who live nearby. These people can suffer health problems such as sleep disturbances because of this kind of noise [4]. On the whole, the size of this problem is really important, according to a CIS's (Sociology Research Center) work about noise [5] in Spain, the 7% of pollution noise annoyances are caused by leisure noise, which is the third most important noise source at night.

However, although environmental noise from entertainment and leisure activities is causing a growing number of complaints from the population of big cities, this noise issue is not covered by the current EU initiatives on environmental noise management [6]. This noise problem is difficult to tackle strategically and technically – no specific standards have been yet established for measurements, methods and indicators; besides, the practical remedies are still limited [7].

About the city councils, most of them are worried about this problem and they have started to take solutions. The most common measures against this kind of noise are less operation

hours for entertainment places or improve the acoustic isolation [8–10]. So most of the city councils measures are applied in the leisure places and are usually control more these places.

This study starts because of the lack of regulation and guidelines, and the growing number of complains about leisure noise. The aim is know the characteristics, the reason and how the leisure noise changes in the different places, in order to use this information for elaborate a procedure to act in leisure noise problems.

To achieve this aim, this study analyze the spatio-temporal evolution of sound pressure level in leisure areas. Furthermore, it investigates the most influential variables in addressing the sound characterization and evaluation of a leisure area. To develop the procedure for sound evaluation and characterization of leisure areas, three leisure areas of a big-sized city (Madrid) and one of a medium-sized city (Cuenca) were selected. Then, the obtained results were examined in order to find the spatio-temporal pattern of the sound pressure levels in leisure areas, as well as to identify the main sound sources in such areas. Thus, a set of models for estimating the leisure noise levels along a leisure area has been obtained. The use of the procedure proposed in this work allows the accurate estimation of sound pressure level in leisure areas of Spanish cities, and thus, a grounded decision making for the improvement of the sound conditions of leisure areas could be undertaken.

2. Methodology

As stated above, it is necessary to know the variables which have influence in this kind of noise to define a proper methodology.

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The study of the identification of the most influential variables and how they change around a typical leisure area, could lead to the approach of a suitable assessment procedure. The studied variables were:

- Leisure area characteristics.
- Number of people in the streets.
- Building height.
- Width of the street.
- Type of leisure places.

2.1. Leisure areas chosen

There are leisure areas in all Spanish cities with different characteristics like extension, number and type of leisure places inside these areas or building characteristics. So, two different cities have been studied: a big-sized city (Madrid) and a medium-sized city (Cuenca), because these have very distinct geographic, demographic, economic and sociocultural characteristics.

Inside these cities, three leisure areas in Madrid and the unique in Cuenca have been measured. As, there are many leisure areas in Madrid; it was necessary to chose between all of them; the decision was that the study were focused on the city center, because it is the most typical place and where there are most of the complaints.

Finally, the chosen night leisure areas were: “La Latina”, “Malasaña” and “Huertas” in Madrid and “La Calle” in Cuenca. All of them have different characteristics like size, kind of leisure places or street characteristics so these areas are representative of the most of leisure areas in Spain. The most important characteristics of these areas have been summarized in Table 1.

2.2. How measurements were taken

A measurement procedure has been defined in order to achieve the aims of this research because there is not a specific law to do this kind of measurement. In this way, two kind of measurements were taken: a long time measurement in a fixed point in each leisure area, and a so called “soundwalker” around each area.

The fixed point measurements acquire the temporal noise behavior and the soundwalker measurements obtain continue noise data along a path and takes cheaper measurements than with fixed point measurements. So, the soundwalker technique allows to diagnose the noise pollution in each leisure area, and the knowledge of how and why the noise in the different streets evolution.

Both measurements have been taken in October, because in this month the leisure activities are moderate. Summer or winter months have not been considered, as in these months the leisure behaviors are more radical. Also weekends with more than 2 days off have been avoided because those weekends do not have a representative behavior of the annual leisure.

2.2.1. Long time measurements

The long time measurements were taken with an averaging and integrating sound level meter (BK2250) following the environmental noise law recommendations [6].

To do this measurement, the sound level meter was placed in a balcony (about 4 m height) of a house placed in a representative street of each night leisure area during the weekend.

2.2.2. Soundwalker measurements

The soundwalker measurements were taken with a binaural recorder (SoNoScout an equipment of B&K) around each leisure area taking into account the bibliographic recommendations [11–13].

The path was defined with the aim of being the soundwalker representative of the whole leisure area and measuring streets with more or less leisure places in order to characterize different situations in each area. Furthermore, the most typical streets in each area have been included, as it is shown in Fig. 1.

The soundwalker was done between 1:30 and 3:00 am; This is the worst case, as during this time the noise is representative of the whole night noise in most of the cases. This is due to the fact that people who usually stay in the street are outside because the weather is not cold, and because people have not come back yet to home because the pubs are still opened.

The soundwalker tours took between 10 (in the smaller leisure area placed in Cuenca) and 25 min (in Madrid leisure areas) at a constant speed through the selected streets in each leisure area during the same time period.

2.3. How density of people was measured

As a relevant variable in the generation of noise in the leisure areas, the number of people in the street was measured taking photos and counting the number of people.

Street photos were taken with a camera focused over the street. This camera was placed together with the sound level meter in the same balcony and at the same time. In this way it is possible to compare the density of people with the noise level.

2.4. Analysis of measurements

The variables, which have influence in this kind of noise, have been analyzed as follows:

- Temporal behavior of noise (long time measurements)
Evaluador software (B&K) and Microsoft Excel have been used to analyse the fixed measurements. The L_n (equivalent continuous noise level during the night) and the temporal behavior of noise ($L_{Aeq,15}$ during the whole night) have been extracted to know the average level during the night and how the noise changes during the night. These measurements were used to compare and validate the soundwalker results.

Table 1
Summary of leisure areas characteristics.

Leisure area	Acoustic qualification	Street width (Average)	Buildings height	Traffic	Principal leisure places	
Madrid	La Latina	Residential Toledo St. commercial	9.5 m	5–6 Floors Average 18 m	Allowed but it is low	Bars Restaurants
	Malasaña	Residential	7.8 m	5–6 Floors Average 18 m	Allowed but it is low	Pubs Bars
	Huertas	Residential Sol Sq. and Jerónimo St. commercial	7.5 m	5–6 Floors Average 19 m	Limited access for motor vehicles	Pubs Bars Discos
Cuenca	La Calle	Residential	6.5 m	4–5 Floors Average 14 m	Pedestrian	Pubs

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