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EFFECT OF TRAFFIC FLOW ON URBAN NOISE MODELLING

Valentín Gómez Escobar[1*] **Sergio Paloqueme Váquez**[1] **Guillermo Rey-Gozalo**[1]
[1] Laboratorio de Acústica (Lambda), Departamento de Física Aplicada, Instituto Universitario de Investigación para el Desarrollo Territorial Sostenible (INTERRA), Escuela Politécnica, Universidad de Extremadura, Avda. de la Universidad, s/n, 10003 Cáceres, Spain

ABSTRACT

Noise mapping presents multiple challenges to ensure that the simulated values are as close as possible to the actual noise values.
For the optimization and testing of noise maps, it is necessary to measure control points (which must be characterized by a sound level and by a vehicle flow, in the case of road traffic noise maps).
A question arises: how to take into account the effect of traffic on streets near the control point?
This paper presents the preliminary study carried out in the city of Cáceres (Spain), on the effect on the simulated sound level of the variation of the flow of vehicles in the streets adjacent to the one in which a control point has been established. Different assumptions regarding the traffic on these streets have been considered.
The results show that, in streets without heavy traffic, the effect of traffic variation in adjacent streets can be significant.

Keywords: *Noise, noise mapping, traffic noise, uncertainty***.**

1. INTRODUCTION

Noise is one of the main pollution factors that affect modern cities. Therefore, noise assessment is an important task in order to evaluate the quality of life of citizens.

Noise assessment can be carried out both from in situ measurement or by simulation software. In any case, both methodologies are complementary since, for instance, simulation results must necessarily be compared with in situ measurements to corroborate the quality of the developed noise model.

According the European Environmental Noise Directive (END), strategic noise maps are the main tool for noise assessment [1].

Noise simulation implies an adequate selection of the noise sources present in the environment. In this work only road traffic noise is considered, both in simulation and in the in situ measurements carried out. This noise source is one of the most important in modern developed cities and is related to different diseases [2,3]. For the strategic noise maps in which road traffic noise is considered, the European Commission established in 2019 a unique method for noise simulation (CNOSSOS-EU) [4].

When simulation an environment, it is necessary to collect different data such as meteorological conditions, road surface, absorption of buildings, vehicle categorization flows, vehicle speed, etc. Due to the large variability of this data, some assumptions are usually made, some of them included in official documents [5,6].

For the validation of noise models it is necessary de comparison of the noise levels obtained with the computational models with in situ measurements. The uncertainty obtained in this comparison can be influenced by different factors [7-8]

For the aforementioned validation, the characteristics of vehicles traffic at the point of evaluation are taken. However, in some streets, mainly in those with low vehicles

*Corresponding author: valentin@unex.es. s

flow, the influence of noise coming from nearby streets could be important and data vehicles flow data from these streets are usually not available.

The purpose of this work is to make a first approximation to the possible effect of nearby streets on traffic noise assessment in noise modelling.

2. METHODOLOGY

2.1 Studied city

The simulation and measurements were carried in the city of Cáceres. The city of Cáceres is located in the southwest of the Iberian Peninsula. The population of the city is close to 95,000 inhabitants (although this number increase to more than 110,000 during most of the year due to the influx of more than 10,000 students at the University of Extremadura and, also, numerous tourists). Cáceres is a UNESCO World Heritage site.

2.2 Sampling methodology

For the present study, several sampling points were chosen in different streets of the city. To take into account la variability of traffic flow in the city, the sampling points were distribute among the different types of streets in Cáceres,

Thus, before the selection of sampling points, the streets were classified according to the previously proposed categorization method [9-10]. In Figure 1, a color-coded map of Cáceres is shown for the different categories of streets (only sampled streets are indicated).

Sampling points were randomly selected inside each category and prior to the measurement, each sampling point was analyzed in depth and possible adjacent streets that could influence noise were selected.

During sampling, some photographs of the sonometer location were taken.

At each sampling points, two measurements of 15 minutes of duration were carried out. All measurements were performed in diurnal period (from 7:00 to 19:00). The measurements were carried out on different working days, following the ISO 1996-2 standard [11].

All the measurement were carried out in years 2020 and 2021.

2.3 Noise modelling

The Predictor v.2024 software was used for noise mapping. The following configuration options was used for noise modelling:

• Computational model: CNOSSOS-EU
• Reflection number: 1
• Meteorological conditions: Default values of Toolkit 17 of the WG-AEN [5] were considered.
• Building height: Ground floor—4.5 m; each additional floor—3 m.
• Absorption of buildings and barriers: Reflective
• Vehicles speed: Maximum speed allowed for each street.

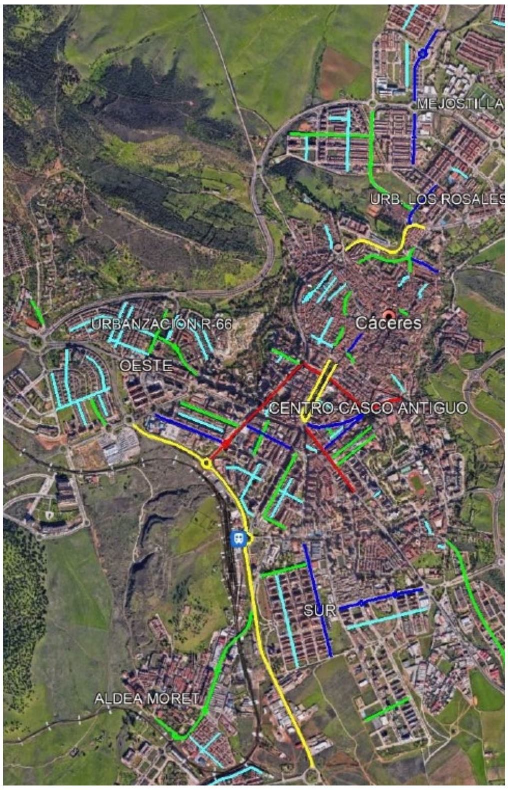

Figure 1. Sampled streets of Cáceres.

The receiver points were located in the noise model at the same position where in situ measurement were taken. In the case of photographs were the exact position of the sampling point could not be precisely determined, the sampling points was discarded.

A total of 100 sound measurements were estimated.

2.4 Street traffic flow

The traffic flow of the street on which the sampling point was placed was determined from the data obtained during sampling.
For the traffic flow of the adjacent streets, two cases were considered:

+ Case 1: No traffic flow
+ Case 2: Average traffic flow of the type of street.

For the present work, three types of street were considered [5]:

- Small main roads. In navy blue and red colors in Figure 1.
- Collecting roads (collecting traffic from service roads and leading it to & from main roads). In green color in Figure 1.
- Service roads: (mainly used by residents living there). In light blue color in Figure 1.

3. RESULTS AND DISCUSSION

As mentioned above, a total of 100 measurements/simulations were considered for the present study. These points were classified according to their location as shown in Table 1:

Table 1. Classification of sampling points considered.

Type	Description	Number
A	Small main roads	34
B	Collecting roads	33
C	Service roads	33

Noise values of the simulations for each sampling point for the two conditions considered (no traffic on adjacent streets and average traffic of the street type on adjacent streets) were compared with the measured level. The differences between the measured and the simulated levels are shown in Figure 2, for no traffic on adjacent streets, and in Figure 3, for average traffic flow.

As can be seen, in both cases, the simulated values are quite similar to the measured values, with very few points where the differences are greater than 3 dBA.

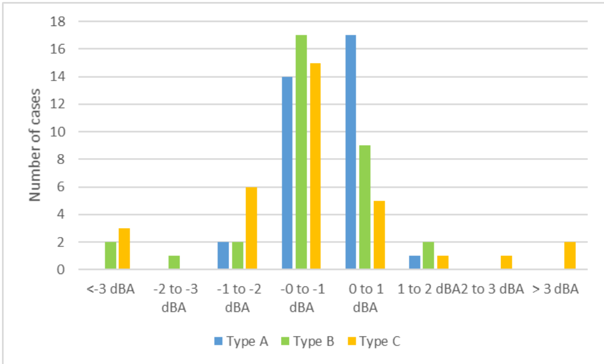

Figure 2. Differences intervals between measured and simulation noise values. Case 1.

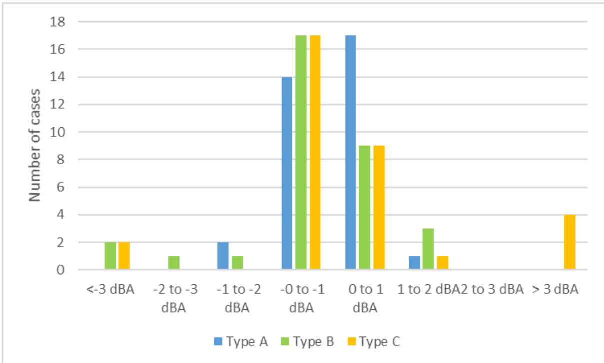

Figure 3. Differences intervals between measured and simulation noise values. Case 2.

In Table 2, comparison between the differences obtained for the two considered cases are shown

Table 2. Comparison between differences of the two considered cases.

	Type A	Type B	Type C
<-1 dBA	0	0	3
-0.5 to -1 dBA	0	0	5
-0 to -0.5 dBA	5	15	22
equal to 0	29	18	3

As can be seen, in the Type A sampling points, the differences between considering the traffic flow in the adjacent streets (case 1) and considering the average traffic flow (case 2) are very small and only in 5 points (15%) small variations (less than 0.5 dBA) are observed in the simulated values. In Type B sampling points, small variations (less than 0.5 dBA) are also observed, but in a larger number of points (45%). Finally, in the Type C streets, service roads, there are greater differences between the two cases considered. Thus, in eight of the considered points (24%) the differences are greater than 0.5 dBA (greater than 3 dBA in 3 points – 9%-) and in 22 points the variations are small (less than 0.5 dBA) (67%).

4. CONCLUSIONS

The comparison between the measured and the simulated noise values at 100 measurement points in the city of Cáceres shows that the consideration of traffic on the adjacent streets to the street where measurements are taken can be important, mainly on service roads (those streets used mainly by the residents who live there).

Thus, in these streets, where the noise due to road traffic is not very important since the traffic flows are small, the influence of nearby streets with more traffic should be taken into consideration as, in some cases (about 35% in this study) the differences in the simulated values without consideration of traffic may lead to differences of more than 0.5 dB.

5. ACKNOWLEDGMENTS

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6. REFERENCES

[1] END: *Directive 2002/49/EC of the European Parliament and of the Council of 25 June 2002 relating to the assessment and management of environmental noise (END)*. Brussels: The European Parliament and the Council of the European Union; 2002.

[2] A. Ndrepepa and D. Twardella: "Relationship between noise annoyance from road traffic noise and cardiovascular diseases: A meta-analysis", *Noise and Health*, 13, 5), 251-259, 2011.

[3] E. van Kempen and W. Babisch: "The quantitative relationship between road traffic noise and hypertension: A meta-analysis", *Journal of Hypertension*, 30, 6, 1075-1086, 2012.

[4] *Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council*. Brussels: The European Parliament and the Council of the European Union; 2015.

[5] WG-AEN: "Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure". European Commission Working Group- Assessment of Exposure to Noise (WG-AEN); version 2, 13th August 2007.

[6] Spanish Government: "*Guía básica de recomendaciones para la aplicación de los métodos comunes de evaluación del ruido en Europa (CNOSSOS-EU)*", 2022

[7] G Rey Gozalo, V. Gómez Escobar, J.M. Barrigón Morillas, D. Montes González, and P. Atanasio Moraga:" Statistical attribution of errors in urban noise modeling," *Applied Acoustics*, 153, 20-29, 2019.

[8] G Rey Gozalo, and V. Gómez Escobar: "Uncertainty evaluation of road traffic noise models in two Ibero-American cities," *Applied Acoustics*, 180, 108134, 2021

[9] J.M. Barrigón Morillas, V. Gómez Escobar, J.A. Méndez Sierra, R. Vílchez-Gómez, J.M. Vaquero, and J. Trujillo Carmona: "A categorization method applied to the study of urban road traffic noise," *J. Acoust. Soc. Am.*, 117, 2844–2852, 2005.

[10] J.M. Barrigón Morillas, G. Rey Gozalo, D. Montes González, R. Vílchez-Gómez, and V. Gómez Escobar: "Variability of traffic noise pollution levels as a function of city size variables," *Environmental Research* 199 111303, 2021

[11] ISO 1996-2: 2017: *Acoustis- Description, measurement and assessment of environmental noise. Part 2: Determination of sound pressure levels*". International Organization for Standardization, Switzerland, 2017.