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Automotive traffic noise and urban public spaces: a case study in the municipality of Vitória, state of Espirito Santo/ES

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ABSTRACT

In contemporary cities, and usually without realizing it, the population has been exposed to high sound pressure levels, which besides causing discomfort, can lead to health problems. Considering that a large part of this noise comes from emission from motor vehicles, this research aims to evaluate the sound behavior in sound environments configured by voids in the urban fabric, in order to identify whether open spaces can act as attenuators of sound levels. To obtain the expected results, the methodology used was structured from a review of the state-of-the-art and computer simulations relating the variables that influence the formation of urban space and sound emission and propagation, taking as a case study an urban portion of the municipality of Vitória/ES. In parallel, questionnaires were applied to evaluate the user's perception of their exposure. The measurement results indicated that the sound pressure levels caused by traffic noise are above the limit tolerated limit by the NBR norm 10151:2000 for the daytime period. In turn, the results obtained from the population indicated that there is little perception of noise by the users of the spaces surveyed.

KEYWORDS: Urban noise. Urban voids. Noise pollution.

1. INTRODUCTION

The World Health Organization (WHO) defines health as a state of complete physical, mental and social well-being and not merely the absence of disease or infirmity (WHO, 1946). On the other hand, Segre and Ferraz (1997) questioned this definition, adding the possibility of conceptualizing health as a state of reasonable harmony between the subject and his/her own reality.

In cities, one of the most democratic ways of using the urban space for activities that may be related to health and well-being takes place in public areas. These areas currently enable different activities; squares and parks are particularly sought after for the promotion of well-being, sports, and other activities, that is, they are an invitation to leisure, frequently leaving users with the feeling that they get, even if for a short period of time, the much desired quality of life. However, it is questionable whether these areas fully contribute to the purpose for which they are intended, especially regarding environmental quality.

The rapid expansion of the world population, estimated by the UN at seven million in 2009, has the increase of pollution of various types as one of its consequences, which is most noticeable in urban centers (UN BR, 2016). The Agenda 21 (MMA, 1992, p.5) recorded some action programs that contemplate the subjects of air pollution, water pollution, use of pesticides, solid residues, noise, and radiation, among others. Out of the types of pollution mentioned, some are clearly perceptible by the senses of sight or smell, while others act more discreetly. Urban noise, for example, is a type of pollution present in human activities due to the use of maintenance and daily use equipment, loudspeakers, planes, cars, etc. As people get used to it (due to a phenomenon called auditory accommodation), it is one of the least noticed types of pollution. According to the WHO report (2011), traffic noise ranked second among environmental stressors in an evaluation regarding its impact on public health in six European countries.

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Therefore, this study aims to evaluate the noise emission of automotive traffic in the municipality of Vitória and the level of awareness of the population on the subject. This study also intends to prove the potential for mitigating urban voids regarding this type of noise.

2. OBJECTIVES

The objective of this study is to analyze the behavior of traffic noise in relation to the urban conformation of the public space, evaluating whether these areas work as attenuators of the sound pressure level. In parallel, the objective is to evaluate whether these public spaces, normally equipped to promote activities related to improving the quality of life and health of the population, are exposed to inadequate sound pressure levels, as well as whether users perceive this possible acoustic discomfort.

The studies were developed having previously selected urban plots in the municipality of Vitória, state of Espírito Santo, as territorial cutout.

Objectively, the sound pressure levels of previously selected urban plots were evaluated through computer simulations and then validated with field measurements. In another step, the population was surveyed regarding the level of perception in relation to noise, whose results would be correlated with those of the simulations.

3. METHODOLOGY

The research methodology was established considering the literature review, which followed all the steps, and the obtaining of data from simulations and the field research with users of open spaces, being structured in 05 (five) steps, according to the methodology overview shown in Table 1.

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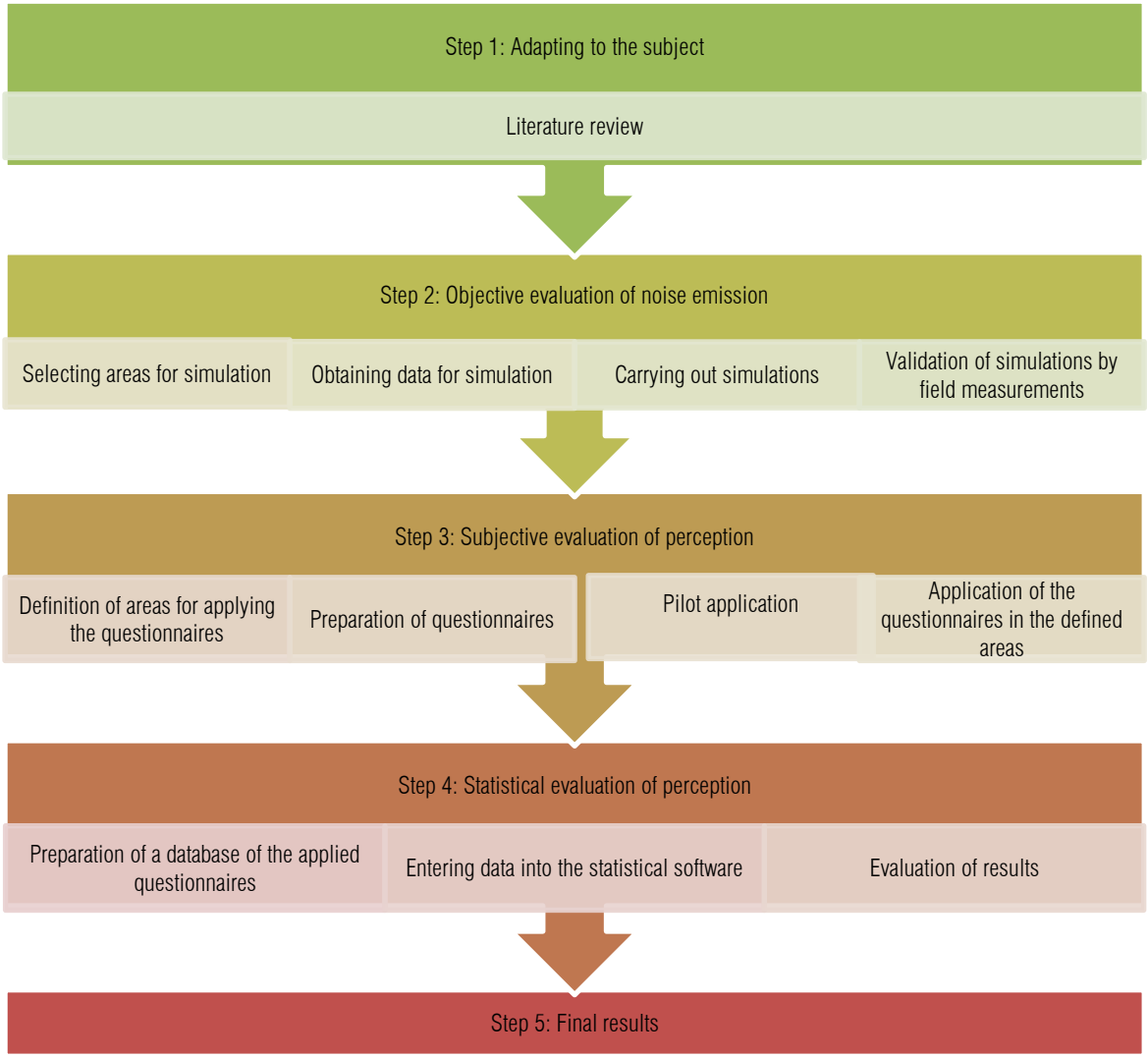
Table 1: Methodology overview

Source: The authors



The following criteria were used to select the simulation areas (Figure 1):

- Belonging to the continental portion of the municipality of Vitória;
- Being near or in an area defined as a Controlled Occupation Zone, consisting of areas with mixed use (residential and non-residential) and with complete basic sanitation infrastructure, water supply networks, and sewage collection and treatment;
- Being in an area of public use with free spaces, preferably squares, parks, and green areas, according to art.189 §4 of Law 6705/2006 (PMV, 2006);
- Having an area greater than 200m²;
- Being approximately 250 meters away from collector or arterial roads.

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Figure 1: Areas researched with simulation (Step 2)

Source: The authors

For the subjective evaluation of perception (Step 3), a questionnaire was designed, which was applied in five simulated areas, selected in the form of a draw, and considering area 4 as the control. The selected areas were 1,2,3,4, and 9 whose names became, respectively, area A, area B, area C, area D, and area E.

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Figure 2: Areas surveyed with simulation and questionnaire (Step 3)

Source: The authors

To obtain the sample size, a population of 10,000 people per month at the time analyzed was considered. The sample size was 375 questionnaires, considering a significance level of 95% and a sampling error of 5%.

After completing the questionnaires, the data were entered into a spreadsheet and used as a database. Each item of the questionnaire was considered a variable, and these were grouped to verify the association between the variable 'area' and the other variables using the Chi-square test with a significance level of 5%.

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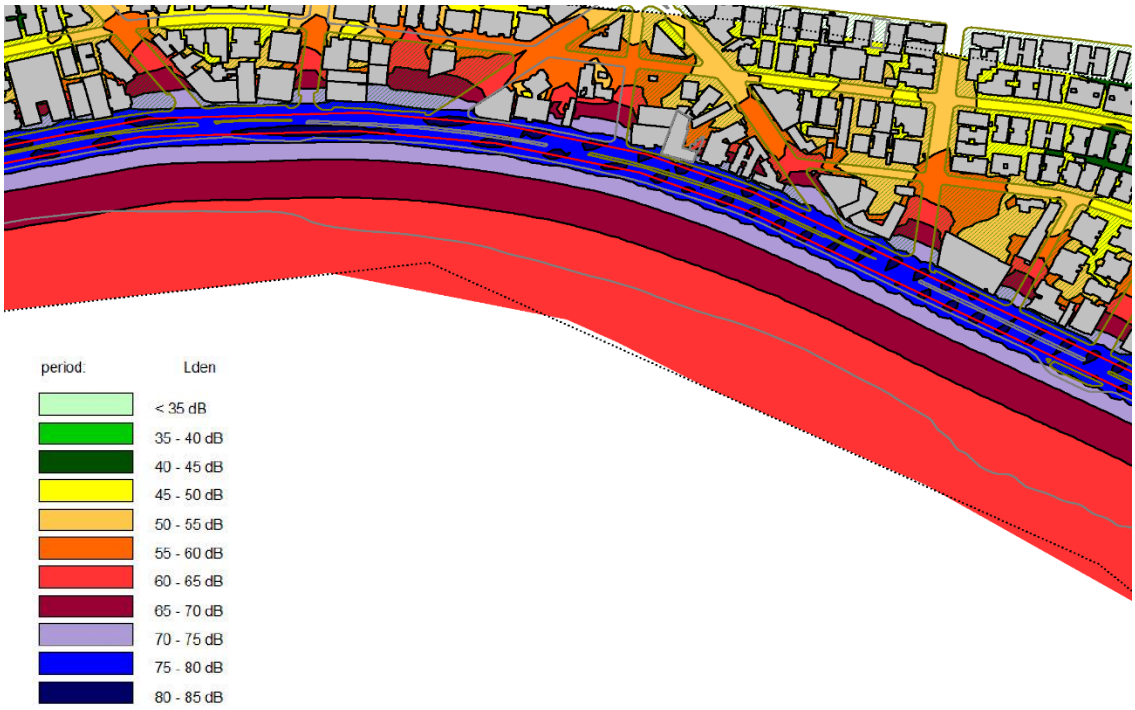
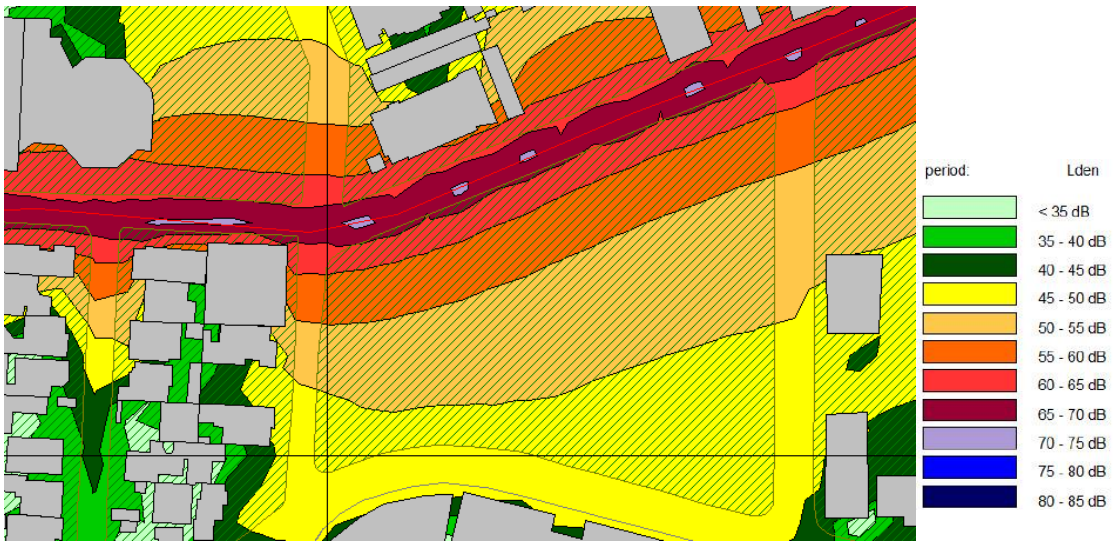
4. RESULTS

Figure 3: Excerpt from the Area 1 simulation.



Source: The authors

Figure 4: Excerpt from the Area 9 simulation.



Source: The authors

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Table 1: Comparison between simulated and field-measured levels for the sound source.

Area	Decription of the area	Simulated level	Field level	Difference found
		(dB)	(dB)	
1	Camburi waterfront - Jardim da Penha neighborhood	75-80	78.00	0
2	Philogomiro Lannes square - Jardim da Penha neighborhood	65-70	68.20	0
3	Regina Frigeri Furno square - Jardim da Penha neighborhood	65-70	67.00	0
4	Fernando Ferrari avenue - Mata da Praia neighborhood	75-80	78.20	0
5	Des. Dermerval Lírio avenue –Mata da Praia neighborhood	70-75	69.20	0.8
6	Jacob Suaid square - Mata da Praia neighborhood	65-70	71.20	1.2
7	Camburi waterfront –Jardim Camburi neighborhood	75-80	72.20	0
8	Alcino Pereira Neto street - Jardim Camburi neighborhood	70-75	69.20	0.8
9	Isaac Lopes Rubim avenue - Jardim Camburi neighborhood	65-70	64.50	0.5
10	Fazendinha municipal park –Jardim Camburi neighborhood	65-70	72.80	2.8

Source: The authors

The degree of uncertainty, or acceptable error, in this study was considered as ±3.0 (three) dB. Note that all areas were within the tolerable limit, thus being considered valid. Considering the level established by the NBR norm 10151:2000 of 65 dB as acceptable for mixed areas with recreational vocation in the daytime, it is inferred that out of the five areas actually surveyed, four have sound emission levels above the recommended.

5. CONCLUSION

The simulations graphically demonstrate that the incident levels of the noise sources of automobiles are dissipated by the free field and have their intensity decreased with distance. Consequently, the importance of public open spaces for attenuation of urban traffic noise was confirmed.

There is no way to disregard the influence of visual elements and tactile sensations, such as the breeze and changes in temperature, which can eventually mask or reduce the sensitivity to uncomfortable sound stimuli. However, through field simulations and

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measurements, it was found that the emission of vehicular traffic noise alone can be considered high for the studied areas, requiring the adoption of public policies for planning and intervention for its attenuation. In addition, promoting awareness among the population on the city's acoustic reality is of fundamental importance as a first step towards combating this type of polluting agent.

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