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STUDY OF VITORIA-GASTEIZ BY CATEGORIZING CHARACTERISTICS ROADWAY

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ABSTRACT
In the city of Vitoria-Gasteiz (País Vasco, Spain) a preliminary urban noise survey was conducted. The city was categorized by its roadway characteristics. Thus, four different categories were studied with random selection of sampling points. Measured noise levels can be considered high (over 65 dBA) in the city. The study was developed in two different months, one on vacation period (August) and the second in a working month (September). Results showed differences between both months. Relationships between energy-averaged sound level (L_{eq}) and statistical levels of exceedance (L_x) were established. Finally, a regression equation of L_{eq} was developed as a function of logarithm of the number of vehicles per hour.

1 - INTRODUCTION
Different studies are being carried out, relatives to urban noise, in many cities of the world from some decades ago, which treat either independent or simultaneously some of the most interesting aspects: sources, level of noise contamination, level of noise exposition, physiological or psychological effects on the population, etc. [1-3]. In Spain, the first works, in this sense, appear finishing the 70's. Actually there are studies of the urban noise in many Spanish cities, even in some of medium and small size [4-5]. The city of Vitoria, with a population of about 218 000 inhabitants, has an old part clearly different of the modern one.
The present work is focused on the traffic noise, assuming as in other studies, that it represents the fundamental component of the urban noise [5-6].

2 - METHODOLOGY
Method of selection of the measuring points. It was decided to select the measuring points from an urbanism analysis of the city, with a stratification according to the utilization of the public roads. Following this stratification the selection of points was random to avoid the possibility of introducing systematically errors by using an arbitrary selection.
Measurements and equipment. Measurements were made according to ISO 1996 normative, filling a card with the relevant information for the analysis. The considered sound levels were: L_{eq}, L_{10}, L_{50}, L_{90}, L_{MAX}, L_{MIN}.
Measurements of 15 minutes were taken on August and September (year 1999) on working hours and days (from 8:00 to 20:00 and from Monday to Friday). Each selected point was measured both months so that is characterized by two measurements.
All the measurements were made by using a sound level meter B&K2231 with the corresponding tripod and anti-wind screen.

3 - CATEGORIZATION OF STREETS
To classify streets it was considered the existence of limits points in the city. These points were in the income roadways of the city, including in the definition of income roadway only those roadways that connect the city with other peninsular cities. Roadways that communicate the city only with small regional cities were considered as internal use roadways or streets. In addition, a central zone was selected

as the zone at which all the income roadways arrived inside the city. The different established categories were:
1st Category: Preferential streets whose function is to communicate the external limit points among themselves and to connect these points with the central zone.
2nd Category: Streets that are prolongation of the previous ones and get inside the central zone. In this category are also included the streets that join the central zone.
3rd Category: Those having origin or destine at the 1st or 2nd categories.
4th Category: Different streets belonging to diverse squares, neither too important nor classified in the upper categories.
This categorization was based on that one made in previous studies in cities of a similar size (Cáceres and Badajoz) [7-8]. In these studies 1st and 2nd categories are similar to ours, but the 3rd and 4th ones have been redefined because some differences have been found in those cities.
Each category had the same number of possible measuring points with the same probability of being chosen, by this way the influence of the length of the street is indirectly introduced. Two points are considered equivalent if there is not any cross between them, in that case, one point is eliminated and chosen a new one.

4 - RESULTS

Categories and months. In total 192 measurements were made, 48 for each category. Table 1 shows the total statistical distribution of L_{eq} values for the whole set of taken samples. It can be observed that the proportion of values with levels higher than 65 dBA changes from August (65.6%) to September (87.5%). This value, 65 dBA, can be considered as the exposure diurnal limit [9].

L_{eq} (dBA)	50-55	55-60	60-65	65-70	70-75	75-80	80-85
August (%)	0	12.5	21.9	43.7	21.9	0	0
September (%)	0	3.1	9.4	51.0	32.3	4.2	0

Table 1: Statistical distribution of L_{eq} values in the two considered months.

Figure 1 shows the statistical distributions of the equivalent levels (L_{eq}) obtained for the four studied categories in the two months. In both months, 1st and 2nd category seem similar, but in the 3rd and 4th ones lower intervals of L_{eq} take more importance. These results are similar to previous studies [7-8]. Differences between both months are bigger in the 3rd and 4th categories: August dominates low intervals in opposite to September in the high intervals.

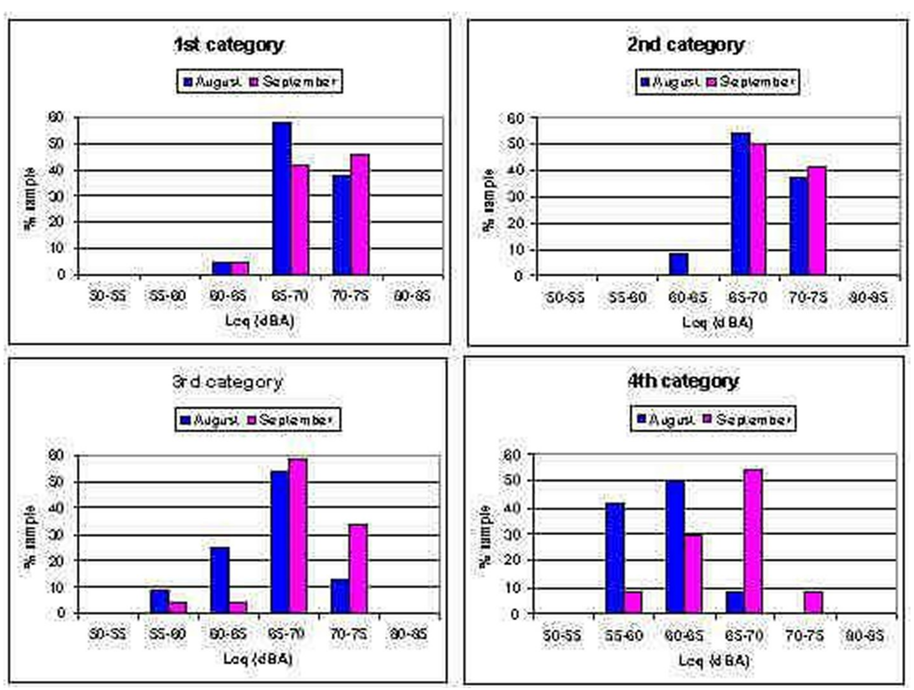

Figure 1: Histograms of L_{eq} for all the considered categories and months.

Relations between measured levels. Many times it is interesting to obtain some levels from other measured ones. Relationships among the different determined levels have been studied. Table 2 shows the calculated parameters, by fitting the percentile levels L_{10}, L_{50} and L_{90} against L_{eq}, with an equation type $L_x = a\, L_{eq} + b$.

	August			September		
	$L_{10}=f(L_{eq})$	$L_{50}=f(L_{eq})$	$L_{90}=f(L_{eq})$	$L_{10}=f(L_{eq})$	$L_{50}=f(L_{eq})$	$L_{90}=f(L_{eq})$
Slope (a)	1.04	1.05	0.64	0.95	1.16	0.92
Origin (b)	0.68	-7.70	12.17	6.71	-14.72	-5.19
Reg.Coeff.	0.97	0.90	0.66	0.98	0.94	0.72

Table 2: Regression parameters for the relations between levels.

It can be observed a better relation for L_{10} and L_{50} with L_{eq} than for L_{90}. Results for September show a higher regression coefficients. This is compatible with a higher importance of the traffic noise in September, considering this source as the most important component of the urban noise.

Relation with the traffic volume. According to different authors [9-10] it is possible to establish a relation between L_{eq} and the logarithm of the traffic flow (Q) in number of vehicles per hour. Figure 2 shows a graphic with the data of L_{eq} for both months. The linear regression follows the equation: $L_{eq} = 9.39 \log Q + 41.69$ (Regression coefficient 0.83).

The obtained results are similar to those obtained in the bibliography [7].

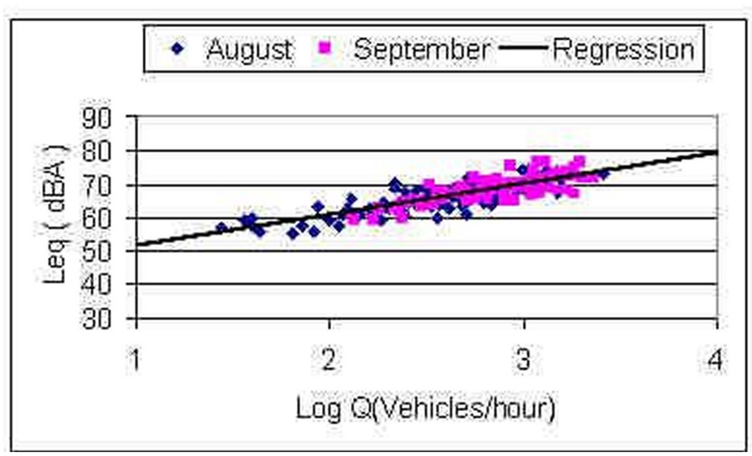

Figure 2: Relation between L_{eq} and the traffic flow Q (vehicles/hour).

5 - CONCLUSIONS

- Categorizing of the city according to its roadway characteristics seems to be an useful and an adequate method to study the noise in a city. Nevertheless, improvements in categorization would be desirable.
- It can be observed important differences for L_{eq} between September and August. Besides, a great percentage of this level were over 65 dBA (65,6 % in August; 87,5% in September).
- A clear improvement in the relationships among statistical levels and L_{eq} was found from August to September. This behavior is more relevant between L_{90} and L_{eq}.
- The relation of the urban noise with the traffic flow is clear for both months, even for low traffic flow. The results show that traffic noise is commonly the main noise source in the city.

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