inter.noise 2000
The 29th International Congress and Exhibition on Noise Control Engineering
27-30 August 2000, Nice, FRANCE

I-INCE Classification: 6.9

NOISE MAPS: METHODOLOGY, CRITERIA AND CURRENT SITUATION; MADRID NOISE MAP

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Keywords:

ABSTRACT

The lack of a pattern procedure for performing noise maps results in a variety of proceedings and methodologies that, in most cases, complicate results comparison and, therefore, possible conclusions and recommendations and their application. In this paper the proceeding and methodology followed in the performance of several noise maps is presented, taking into account in experimental measurement: a) Spacial distribution process. b) Temporal distribution process during day and nighttime periods c) Samples length. d) Noise evaluation indexes and data processing procedure. e) Noise map display methodology by means of GIS. f) Achievement of noise-generating equations. g) Conclusions and recommendations. On the other hand, we consider making a inquiry simultaneously with measurements to be essential. By making 27 questions important data have been obtained about noise sources, annoyance, effects, etc. in three levels: a) Neighbors. b) Schools. c) Townhalls. All data from inquiries have been processed and correlated with the object of obtaining as much information as possible about the situation. Logically, the three inquiries have some shared questions and some different.

1 - INTRODUCTION

The 17 towns selected have 1,447,722 inhabitants as a whole and can be classified in three groups: a) more than 100,000 inhabitants (6 cases, all that exist in the region of this size without the capital), b) less than 100,000 and more than 30,000 inhabitants (7 cases, all of them with this size) and c) less than 30,000 and more than 3.000 inhabitants (4 cases).
Most of the cities can be reached by interurban buses and twelve of them have train stations.

2 - NOISE MAP DEFINITION

A noise map of a town or urban area is based on the study of sound levels in different places within the city or town. A meaningful noise level is obtained in every one of them, as well as temporal variation, because noise never behaves as a static phenomenon in the cities.
Therefore, the city under study is divided into areas where the sound pressure measurements will be taken during different periods that will produce, after adequate integration of the results obtained, a temporal and spatial distribution of the acoustic environment of the city. These values are used to draw the noise map where different color intensities represent existing noise levels, allowing easy recognition of the noise areas.
In this way, the noise map can show where there are noisy areas in the cities. Depending on the environment and characteristics of these areas, the main noise sources within each previously delimited area can be assessed.

3 - PRACTICAL METHODOLOGY – TEMPORAL AND SPATIAL DISTRIBUTION OF THE MEASUREMENTS

3.1 - Grid description

The surface studied covers 67 km^2 surface over all the included towns. A grid is drawn on each town map so as to cover its topography with square elements, whose surface depends on the city size, typically between 100 x 100 m and 300 x 300 m.

The grid covers the urban center in all cases, reaching suburbs in some cases. Measurements were also made in industrial areas, some close to city centers and others farther away. This way sound pressure levels can be measured and compared among different areas.
Measurement locations correspond to the grid nodes, thus obtaining an average of 75 measurement points per town.

3.2 - Temporal distribution of the measurements
The noise environment in a city is not constant throughout the day; samples were taken at different times to obtain noise level variations during the period from 8:00 to 22:00 hours. To do this, four daily periods were defined and four measurements were made on each point, each one of them on a time period. The chosen periods are:

Period 1:	08:00 − 11:30	(beginning of activities)
Period 2:	11:30 − 15:00	(morning activities)
Period 3:	15:00 − 18:30	(afternoon activities)
Period 4:	18:30 − 22:00	(return home and leisure time)

Table 1: Each period's measurement lasted 5 minutes.

Additionally, several special measurements were made, like nighttime measurements in common days or at leisure places, special events and holidays.

4 - EXPERIMENTAL RESULTS OBTAINED
Some results will be presented next from the measurements made on the 17 municipalities, during 1996 and 1997.

4.1 - Mean L_{eq} in the Madrid region
Making averages of the measured L_{eq} on every one of the 17 towns, we obtain the levels we need:

★ Mean L_{eq} in big towns =	**67,8 dBA**
★ Mean L_{eq} in medium-sized towns =	**64,8 dBA**
★ Mean L_{eq} in small towns =	**63,6 dBA**
And averaging again the above values we obtain the mean Leq for the Madrid Region:	
★ **Mean Leq for the Madrid Region =**	**65,7 dBA**

Table 2.

The overall mean is above the 65 dBA recommended by the European Union. While medium and small size towns mean levels are still under that value, big towns are 3 dBA over the limit. Being more specific, 47% of all the measurements taken are above 65 dBA. If we analyze with regard to the town size, we see that big towns have 64% measurements above 65 dBA, medium-sized ones on 37% and the smaller ones on 39%.
Big towns have a more serious environmental problem, and this was expected considering that traffic, the main noise source everywhere, is denser in more populated locations. Some towns have more specific problems like airplane noise (due to close airports or air corridors), road works (less important given they are temporary), etc.
Equivalent level (L_{eq}) daily evolution
By averaging the mean equivalent levels during each of the four time periods in every town, the Madrid Region mean equivalent level evolution from 8:00 to 22:00 can be obtained.
Big and medium-sized towns in the Madrid Region maintain an almost constant noise level during the day, while the small ones show a small decrease both on the first and last time period. Towns above 100.000 inhabitants suffer a much higher noise pollution than the rest, which have similar mean equivalent levels.
In small towns, the equivalent level increases during the second time period (11:30 − 15:00), considerably decreasing on third and fourth periods, as can be observed. This tendency influences the level increase in the Madrid Region as a whole during the second period.

4.2 - Mean L_{max} and mean L_{min} in the Madrid region
L_{max} and L_{min} temporal evolution
In this section the evolution during a workday of these indexes will be shown. Values vary along time periods as shown in figure 2, where mean maximum and minimum levels in big, medium and small towns

are plotted, along with the overall Madrid Region result. The figure also shows the mean equivalent level on the same time periods and town groups in order to compare the levels, their temporal evolution, the degree of similarity among town groups and the ranges covered by the results.
The figure gives an idea of the ranges within L_{max}, L_{min} and L_{eq} vary. Maximum levels are around 15 dBA above equivalent levels, the same difference that exists between equivalent and minimum levels.
As mentioned, maximum levels are similar for all town groups (big, medium, small), giving around 80 dBA during the four time periods. Equivalent levels are a bit more diverse, while minimum levels in different town groups show even more variation, although they are almost constant during the day, big towns have 55.4 dBA and small towns present 46.2 dBA.

4.3 - Percentiles L_{90}, L_{50} y L_{10} in the Madrid region

Only big towns exceed the Madrid Region overall percentiles. Medium-sized towns are less than 1 dB below the Region mean, while the comparison between small towns' percentiles and the mentioned overall percentiles increases the difference to 2−4 dBA.
Considering Madrid Region global values, the difference between mean equivalent level and background noise level is 10 dBA (9 dBA in big towns, 10 dBA medium-sized and 13 dBA small ones). The difference between peak level and mean equivalent level is only 3 dBA (3 dBA in big towns and 2 dBA in medium and small ones).

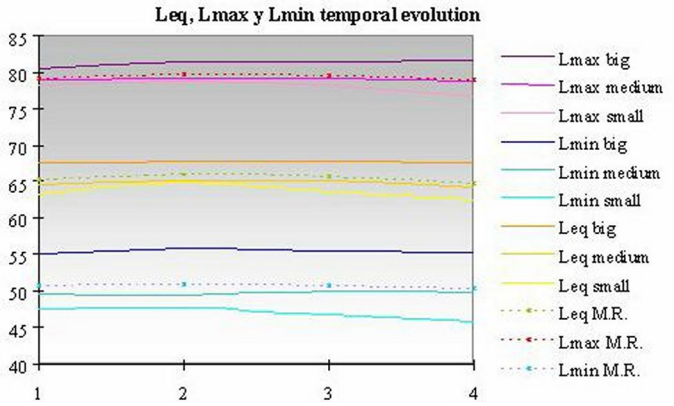

Figure 1: L_{eq}, L_{max} and L_{min} evolution, as a function of time period.

4.4 - Nighttime equivalent level in the Madrid region

Nighttime equivalent noise level evolution in the Madrid Region will be shown here, and also mean evolution in big, medium and small towns.
Figure 2 clearly shows nighttime noise level differences among all town groups; while small towns have levels under 50 dBA at 2:00 that drops below 40 dBA at 4:00, big towns have almost 60 dBA all through the night, rising over 65 dBA at 6:00. Medium-sized towns have values closer to the overall Madrid Region average, with levels around 50 dBA before 6:00, increasing later to 60 dBA.

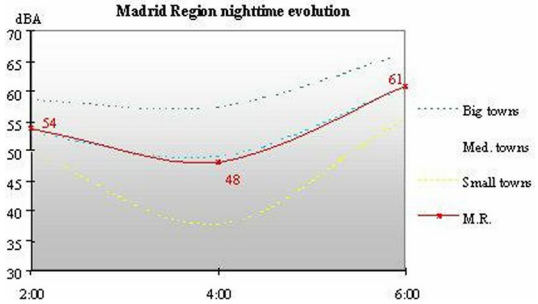

Figure 2.

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