THE EUROPEAN DIRECTIVE ON ASSESSMENT AND MANAGEMENT OF ENVIRONMENTAL NOISE. VARIABILITY IN THE NOISE INDICATORS

PACS REFERENCE: 43.15

Jiménez Díaz S.;[1] Alsina Donadeu R.;[2] Perera Melero P.[3] and Arriaga Sanz JM[a].[4]

1. LEAM. Technical University of Catalonia.
C/ Colom, 11 08222 Terrassa, Barcelona, Spain
Tel. +34 937 398 146
Fax. +34 937 398 022
e-mail: Santiago.jimenez@upc.es

2. Maintenance and Service Sector. Barcelona Town Hall.
3. Environmental Quality Department. Madrid Town Hall
4. Ministry of the Environment. Autonomous Government of Andalusia.

ABSTRACT

The European Directive on the Assessment and Management of Environmental Noise establishes certain assessment methods common to all European Union member states and sets out a number of noise indicators to be used in the drawing of noise maps and planning of acoustic zones.

While all member states accept the noise indicators L_{den} and L_{night} provided for in the Directive, this is not the case with the length of the periods (day, evening, night) comprising L_{den}.

The Mediterranean countries defend a different length for those periods, owing to their different climate and customs.

This study is based on a comparative analysis of the noise indicators in three autonomous communities taken during the different periods provided for by the European Directive.

METHODOLOGY

This study uses data obtained by measuring long duration sound levels in several municipalities in the autonomous communities of Catalonia, Madrid and Andalusia. These three autonomous communities have different customs, climates and geographical locations.

We analysed integrated L_{Aeq} levels hourly in different types of streets, in order to determine how exposure to environmental noise varies with the different periods (day, evening, night), in accordance with the common evaluation methods for the European Union set out in the Directive on Assessment and Management of Environmental Noise [1].

According to Directive 2001/.../EC on Assessment and Management of Environmental Noise, the common noise indicators to be used for drawing noise maps and for planning acoustic zones are L_{den} to evaluate nuisance and L_{night} to evaluate sleep disturbance. The periods to be taken into account are the following:

For the conventional L_{dn} indicator:

Day (15 hours) between 7:00 a.m. and 10:00 p.m.
Night (9 hours) between 10:00 p.m. and 7:00 a.m.

$$L_{dn} = 10 \lg \frac{1}{24} \left(15 \cdot 10^{\frac{L_{day}}{10}} + 9 \cdot 10^{\frac{L_{night}+10}{10}} \right)$$

For the L_{den} indicator adopted by the Mediterranean countries:

Day (14 hours) between 7:00 a.m. and 9:00 p.m.
Evening (2 hours) between 9:00 p.m. and 11:00 p.m.
Night (8 hours) between 11:00 p.m. and 7:00 a.m.

$$L_{den} = 10 \lg \frac{1}{24} \left(14 \cdot 10^{\frac{L_{day}}{10}} + 2 \cdot 10^{\frac{L_{evening}+5}{10}} + 8 \cdot 10^{\frac{L_{night}+10}{10}} \right)$$

For the L_{den} indicator used by Northern European countries:

Day (12 hours) between 7:00 a.m. and 9:00 p.m.
Evening (4 hours) between 7:00 p.m. and 11:00 p.m.
Night (8) hours between 11:00 p.m. and 7:00 a.m.

$$L_{den} = 10 \lg \frac{1}{24} \left(12 \cdot 10^{\frac{L_{day}}{10}} + 4 \cdot 10^{\frac{L_{evening}+5}{10}} + 8 \cdot 10^{\frac{L_{night}+10}{10}} \right)$$

HORA		L_{DN}	L_{DEN} (2h)	L_{DEN} (4h)
7	8	69,9	69,9	69,9
8	9	70,7	70,7	70,7
9	10	72,3	72,3	72,3
10	11	73,1	73,1	73,1
11	12	72,0	72,0	72,0
12	13	72,0	72,0	72,0
13	14	71,3	71,3	71,3
14	15	72,5	72,5	72,5
15	16	71,2	71,2	71,2
16	17	70,8	70,8	70,8
17	18	70,2	70,2	70,2
18	19	71,7	71,7	71,7
19	20	72,0	72,0	72,0
20	21	70,9	70,9	70,9
21	22	70,8	70,8	70,8
22	23	69,4	69,4	69,4
23	0	67,9	67,9	67,9
0	1	65,1	65,1	65,1
1	2	66,1	66,1	66,1
2	3	61,6	61,6	61,6
3	4	62,3	62,3	62,3
4	5	59,8	59,8	59,8
5	6	59,1	59,1	59,1
6	7	61,7	61,7	61,7
		73,3	73,1	73,5

Table 1. Noise indicators for the different periods. Pink shows daytime levels, green shows evening levels and blue shows night-time levels.

Table 1 illustrates the equivalent levels for a full day, shown hourly, as well as the overall noise indicators for the different periods (day, evening, night) for a specific street, obtained through application of the equations for L_{dn} and L_{den} shown alongside. [2]

RESULTS

The sound levels obtained in the three autonomous communities mentioned above were used to calculate the overall nuisance indicators: L_{dn} (day-night noise indicator), L_{den} (day-evening-night noise indicator with a two-hour evening period), L_{den} (day-evening-night noise indicator with a four-hour evening period), and L_{night} (night-time noise indicator) [3], in order to compare results and to rate the effect of the 5 and 10 dBA penalisations introduced by these new indicators for the evening and night-time periods respectively.

Autonomou Communit	Type street	Noise indicators		
		L_{dn} - L_{den} 2h	L_{dn} - L_{den} 4h	L_{den}2h - L_{den}4h
CATALONIA	DISTRIBUTION	0,2	-0,2	-0,4
MADRID		0,2	-0,2	-0,4
ANDALUSIA		0,2	-0,2	-0,5
		0,2	**-0,2**	**-0,5**
CATALONIA	ACCESS	0,2	-0,2	-0,4
MADRID		0,2	-0,1	-0,4
ANDALUSIA		0,2	0,0	-0,3
		0,2	**-0,1**	**-0,3**
CATALONIA	OTHER	0,2	-0,3	-0,5
MADRID		0,2	-0,2	-0,4
ANDALUSIA		0,3	0,0	-0,3
		0,2	**-0,2**	**-0,4**

Table 2. Variation of different noise indicators for different periods.

Table 2 shows the results obtained from a comprehensive sample including all the variables involved. The Table shows the average differences obtained for the noise indicators depending on the type of street and for the different autonomous communities.

The types of streets are divided into three groups:

Access roads: roads leading into the city.
Distribution roads: trunk roads distributing traffic to different zones.
Other streets: all other streets in the urban grid.

First, we compared the conventional L_{dn} indicator to L_{den} (taking the 2-hour evening noise indicator), which will be adopted by the Mediterranean countries. The differences observed show that, taking (two-hour $L_{evening}$), L_{den} for the sample analysed is **0.2 dBA** lower for the types of streets and the communities studied, although this variation is not significant.

The result for L_{den} in comparison with L_{dn}, taking (four-hour $L_{evening}$) for the cases studied, is around **0.2 dBA** higher. This difference is not significant either.

However, the difference found between L_{den} (taking the evening noise indicator of 2 or 4 hours) is between **0.3 and 0.5 dBA** higher for L_{den} (with four-hour $L_{evening}$).

Figure 1 shows the changes in L_{Aeq} for a normal street, and the acoustic behaviour confirms the results obtained. It is interesting to note that during the period between 7:00 p.m. and 9:00 p.m. the sound level is still high and begins to drop off after 9:00 p.m.

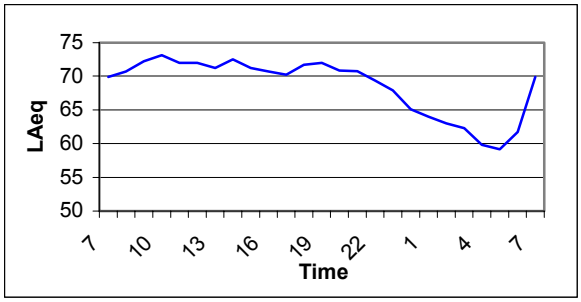

Figure 1. Acoustic profile of a street confirming the results obtained

Table 3 gives the results obtained from analysis of L_{night} (night-time noise indicators). We note that the indicator provided for in the European Directive taking an eight-hour night is, on average, between **0.6 and 0.7 dBA** lower than the conventional indicator taking a nine-hour night.

Autonomous Communities	Type street	Noise indicators
		L_n 9h - L_n 8h
CATALONIA	DISTRIBUTION	0,6
MADRID		0,7
ANDALUSIA		0,7
		0,7
CATALONIA	ACCESS	0,5
MADRID		0,5
ANDALUSIA		0,4
		0,4
CATALONIA	OTHER	0,5
MADRID		0,6
ANDALUSIA		0,6
		0,6

Table 3. Analysis of the night-time noise indicators.

Another important aspect to be taken into account is the difference between the sound level for the day-time period L_d and that for the night-time period L_n. As a rule, it is estimated that L_n is L_d -10, i.e. that the noise level drops at night by approximately 10 dBA.

While this change in sound levels possibly occurred in 1972, when the American Environmental Protection Agency adopted the indicator L_{dn}, this is not the case at present. The drop in sound level from day to night depending on the type of street studied.

In the investigations realized by the Acoustic Engineering Laboratory among different Catalonian cities, the drops in sound observed in 24 hours measurements are as follows:

- Access roads **3 and 4 dBA**
- Distribution roads **3 and 6 dBA**
- Residential streets **7 and 8 dBA**

Figure 2 shows the acoustic profile of a street with a drop of 10 dBA between the daytime level L_d and the night-time level L_n. This acoustic behaviour is found nowadays only in streets with no night-time traffic or in areas where activity decreases considerably.

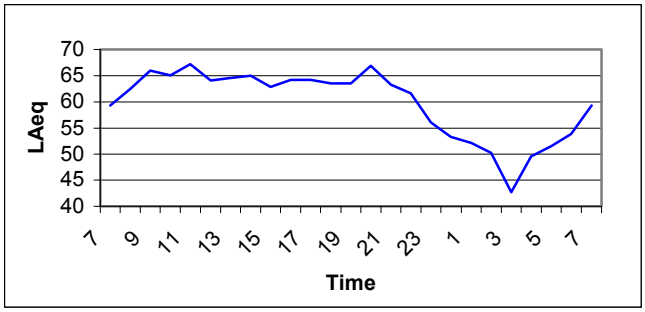

Figure 2. Acoustic profile of a street with a drop of 10 dBA between L_d and L_n.

Just the opposite occurs in streets or areas with a high concentration of leisure activities during the night (amusement parks, tourist towns, areas with music bars and discotheques), where the drop between the daytime and night-time sound levels is negative [4]. Figure 3 shows the acoustic profile of a leisure zone where the night-time level L_n is higher than the daytime level by 14 dBA.

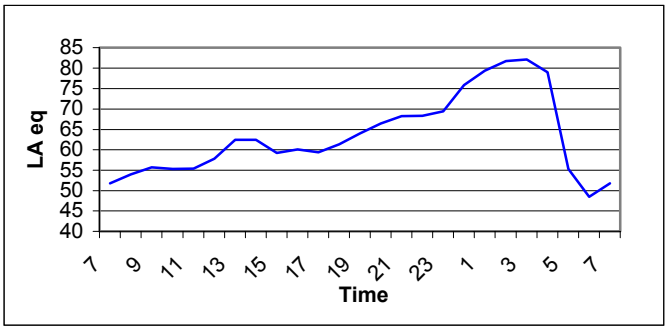

Figure 3. Acoustic profile of a street with leisure activities, where L_d - L_n = -14 dBA

CONCLUSIONS

- The difference observed between the noise indicators provided for in the European Directive, L_{den} with (two-hour $L_{evening}$) and L_{den} with (four-hour $L_{evening}$) and the conventional L_{dn} is $\pm$ **0.2 dBA** respectively.

- Comparison of the two L_{den} indicators gives a level that is **0.5 dBA** higher for the one with the longer evening period.

- The drops observed between daytime and night-time sound levels are:

  Access roads **3 and 4 dBA**
  Distribution roads **3 and 6 dBA**
  Residential streets **7 and 8 dBA**

  An important factor to be taken into account for drawing night-time acoustic maps.

- The results show that variations in noise indicators between the three autonomous communities are minimal, in spite of their different customs, climates and geographical locations.

REFERENCES

1. Common Position (EC) No. 25/2001 approved by the Council on 7 June 2001 for adoption of Directive 2002/49/EC by the European Parliament and Council of the European Union on the Assessment and Management of Environmental Noise Official Journal of the European Communities 18.07.2002.

2. David M. Yeager et al., "Niveles sonoros y su medida. In: Manual de medidas acústicas y control del ruido". ed. C. M. Harris McGraw Hill/Interamericana de España, S.A. Third Edition 1995.

3. Gilles Paque "The EU environmental noise policy" International Meeting on Acoustic Pollution in Cities. Madrid, April 2002.

4. C. Vogiatzis. "Noise in the tourist city of Rhodes, 10 years of efforts in acoustic environment rehabilitation" - INTERNOISE 2001 - The Hague. Netherlands - August 2001.