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

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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\text{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.

\[
L_{\text{dn}} = 10 \log \left( \frac{L_{\text{day}}}{10} + 9 \cdot 10^{\frac{L_{\text{night}}+10}{10}} \right)
\]

For the L\text{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.

\[
L_{\text{den}} = 10 \log \left( \frac{L_{\text{day}}}{10} + 2 \cdot 10^{\frac{L_{\text{evening}}+5}{10}} + 8 \cdot 10^{\frac{L_{\text{night}}+10}{10}} \right)
\]

For the L\text{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.

\[
L_{\text{den}} = 10 \log \left( \frac{L_{\text{day}}}{10} + 4 \cdot 10^{\frac{L_{\text{evening}}+5}{10}} + 8 \cdot 10^{\frac{L_{\text{night}}+10}{10}} \right)
\]

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

RESULTS

The sound levels obtained in the three autonomous communities mentioned above were used to calculate the overall nuisance indicators: \(L_{\text{dn}}\) (day-night noise indicator), \(L_{\text{den}}\) (day-evening-night noise indicator with a two-hour evening period), \(L_{\text{den}}\) (day-evening-night noise indicator with a four-hour evening period), and \(L_{\text{night}}\) (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.
Table 2. Variation of different noise indicators for different periods.

<table>
<thead>
<tr>
<th>Autonomous Communit</th>
<th>Type of street</th>
<th>Noise indicators</th>
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<td>L$<em>{dn}$ - L$</em>{den}$ 2h</td>
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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.
Table 3 gives the results obtained from analysis of L\textsubscript{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.

Another important aspect to be taken into account is the difference between the sound level for the day-time period L\textsubscript{d} and that for the night-time period L\textsubscript{n}. As a rule, it is estimated that L\textsubscript{n} is L\textsubscript{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\textsubscript{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 Catalan 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\textsubscript{d} and the night-time level L\textsubscript{n}. This acoustic behaviour is found nowadays only in streets with no night-time traffic or in areas where activity decreases considerably.
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](image)

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


