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24 HOUR MEASUREMENTS OF NOISE LEVELS IN URBAN AREAS

A Garcia & J V Garrigues

Department of Applied Physics, University of Valencia, Valencia

INTRODUCTION

Along the last decades many environmental noise studies have been carried out in urban areas of different countries along all the world. In general, the noise levels measured in the urban areas show a wide spatial and temporal variability. In that sense, the information provided by diurnal noise maps should be complemented by a study of the time variation of noise levels along the 24 hour of the day, the seven days of the week and even the different seasons of the year (1) (2).

Along the last 15 years, our Laboratory has carried out a high number of such noise level measurements in different cities of Spain (mostly in the Community of Valencia). All the accumulated information has been now analysed in order to investigate the trends of time variation of the noise levels measured in a wide variety of locations and to study the relationships between the differe t indexes of environmental noise in urban areas.

EXPERIMENTAL METHOD

The information presented in this paper is based in the results of noise level measurements carried out in a total of 83 different urban locations in 12 different cities. All these measurements have been made continuously, along 24 hours of day, covering a total of 400 days.

A 1/2 inch condenser microphone (BK4165), a sound level analyzer (BK4426) and an alphanumeric printer (BK2312) have been used. These instruments have automatically carried out an instantaneous measurement of the corresponding sound levels every 0.1 seconds, stored all these data in memory, and computed and printed the hourly values of the mai percentiles (L1, L10, L50, L90 y L99) and the equivalent sound level (Leq) along several consecutive days. For practical reasons, the microphone has not been mounted at street level, but in the windows or balconies of some building in each one of the selected locations (in general, dwellings of relatives, friends or persons willing to collaborate in the study).

In each measurement location were carried out a series of observations regarding six different parameters that, in principle, could be related to the measured noise levels. These parameters are the size of city (measured through population), situation of the location (center, middle or perifery), predominant use of soil (residential, commercial, services or industrial), density of edification (mean height of near buildings), wideness of street (measured from facade to facade of flanking buildings) and road traffic volume (mean value of vehicles/hour in diurnal periods).

RESULTS

Variation of noise levels with sampling time

The time patterns of the noise levels measured in a given location are related to the corresponding "activity level" and, in particular, to the traffic volume variations (3). In general, the time variation of the diurnal noise levels (from 10.00 to 22.00 hours) is small, specially in the high volume locations. Within this period, the mean Leq values are about 66 dBA, coinciding with a mean value of 67.4 dBA found out in a recent survey carried out in a sample of 580 urban locations regularly distributed in the Community of Valencia (4). The lowest values of mean Leq values (about 57 dBA) correspond to midnight period (from 3.00 to 5.00 hour).

Statistical noise level distributions

The instantaneous sound levels mesured in a given urban location re not stationary, but they vary more or less significantly depending of the presence of different noise sources in that location and the time variability of their main characteristics (sound power, spacial situation, etc.). For instance, the noise levels produced by road traffic depend mainly on the traffic volume, type of vehicles and running conditions (3) (5).

The shape of instantaneous noise level distributions corresponding to all measurements has been carefully investigated. In particular, the assimetry of these distributions has been expressed through a parameter A defined conventionally by the equation A = (L10-L50) - (L50-L90). As expected, it has been found that the statistical noise level distributions obtained in urban areas under a wide variety of conditions displays a wide variety of shapes. Most of the distributions are heavily skewed toward the lower level values. It has been noticed that the assimetry of the distributions decreases when the mean noise level increases. The highest values of assimetry correspond to night periods, as a consequence of the relatively higher values of the difference L10-L50. The most negative values of assimetry correspond usually to the diurnal period, when the difference L50-L90 is specially high.

Global noise descriptors

The hourly sound levels measured in a given location exhibit a wide variability along 24 hour period. Consequently, the general evaluation of the acoustic environment of a given location is much better given through some global noise descriptor. The most frequently used global descriptors are the diurnal sound level Ld (equivalent sound level measured between 7.00 and 22.00 hour), the night sound level Ln (same as above, but for the period between 22.00 and 7.00 hour), the 24-hour sound level Leq(24hr) (equivalent sound level for a complete day) and the day-night equivalent sound level Ldn (calculated as above, but increasing the values of sound levels measured along night period with 10 dBA, in order to take account that nightly noise is much more annoying than diurnal noise).

The mean values of these global noise descriptors obtained in the present survey (400 data) have been 66.2 dBA, 61.0 dBA, 65.1 dBA and 69.1 dBA, respectively. These results show that the noise levels existing in many residential areas of Spain (day and night) are quite high.

Weekly noise levels variation

The results obtained in the present survey shows that the Leq(24hr) mean sound levels keep up practically constant from monday to thursday, increase slightly in friday and decrease somewhat in saturday and sunday (in general, it seems that the noisiest day of the week is friday).

Obviously, the differences observed among working days and sundays are not limited to the values of environmental noise global descriptors, but they are also evident in the trends of the corresponding hourly sound levels. In particular, it has been observed that the nightly decrease of sound levels is more slow in sundays than workdays (this fact is related to the night activity). The minimum values of sound levels appear later in sundays (between 6.00 and 7.00 hours) than workdays (between 4.00 and 5:00 hours). Finally, the diurnal activity recover much more slowly in sundays than workdays (the city "awakes" later in the first case).

Correlations between noise descriptors

The precise determination of noise level distributions and percentile noise level values Lx is based in the use of quite expensive instruments (statistical analizers) and it is not usually available in routine measurements. Therefore, it is interesting to investigate the Lx-Leq relationships in order to obtain useful information on the main features of instantaneous sound level distributions and to predict the values of the relevant percentile values from the equivalent sound levels measured in a given urban area.

The analysis of all information obtained in the present noise survey has provided the following regression line equations (values in dBA):

$$L1 = 0.98\,Leq + 10.8 \quad (r = 0.974,\ d = 2.02)$$
$$L10 = 1.05\,Leq - 1.1 \quad (r = 0.973,\ d = 1.98)$$
$$L50 = 1.08\,Leq - 10.2 \quad (r = 0.910,\ d = 3.92)$$
$$L90 = 0.99\,Leq - 9.7 \quad (r = 0.845,\ d = 5.16)$$
$$L99 = 0.90\,Leq - 7.1 \quad (r = 0.794,\ d = 5.59)$$

The best correlation coefficients r and the most accurate estimations (lowest standard deviations d) correspond to the L1 and L10 equations and the worst to the L90 and L99 equations. This result can be expected since the background noise levels (L90 and L99) observed in the absence of significant nearby noise sources are predominantly influenced by the general set-up of a given location, while the L1, L10 and Leq values depend upon the specific noise sources truly existing in its immediate vicinity.

The authors have not found any significant differences among the regression equations obtained for the different cities covered in the present survey (classified as big, medium or small size, according their population). Therefore, it could be concluded that the above equations have a general validity in a wide variety of urban locations. The values predicted by these equations are comparable to those obtained with similar expressions deduced in a more limited analysis carried out some years ago (1).

The regresion equations calculated on an hourly data basis proves that the correlation coefficients between the hourly values of L10 and Leq do not exhibit any significant variation through the 24h of day: the corresponding equation parameters, correlation coeficients and standard deviations show only minor changes through the 24 hour period. However, the correlation coeficients between the hourly values of L90 and Leq change considerably from day to night. Consequently, it can be concluded that the equivalent sound levell Leq is an excellent predictor of L10 at any time, but it is rather a poor predictor of L90, especially during night period.

The main conclusions of the present work coincide with those found by other authors in similar surveys (2) (6). A much more complete analysis of all the information obtained in these urban noise level measurements (cluster analysis) is now in progress.

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