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Noise Level Assessment in Urban Environments

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Abstract

Starting from the most recent research projects on environmental noise, according to the European Directives, in the paper are presented methods for noise mapping in urban areas. Theoretical assertions are illustrated by an example of noise mapping made in Brasov city.

Key words: *noise, level, urban environment, map*

Introduction

Environmental noise pollution is still one of the most important concerns for society, and transportation is seen as a primary source of this concern. Accepting mobility as a basic human need and as an essential precondition for maintaining economic prosperity and wealth in an enlarging Europe, it is clear that the adverse effects of noise must be reduced while facing a continued increase in freight and passenger transport. Research is a key element in reducing such adverse effects.

The research shows that noise can be harmful for one's health, as it increases the risks for high blood pressure and heart attacks (3% of heart attacks in Germany are due to road traffic noise). Noise disturbs sleep and heavily impacts on people's quality of life. Besides its health and social costs, noise has economic consequences in terms of reduced housing value and taxes, as it is a relevant reason for people to move out of cities into suburban areas. Therefore, policy developments and research on noise abatement are moving up on the European political agenda.

According to a recent European Union publication, about 40% of the population in the EU countries is exposed to road traffic noise at levels exceeding 55 dB (A), and 20% is exposed to levels exceeding 65 dB (A) during daytime. More than 30% is exposed to levels exceeding 55 dB (A) during night time. These figures should be put in perspective with the WHO (World Health Organization) guidelines for community noise which require less than 30 dB (A) during the night for a good quality sleep and less than 35 dB (A) in classrooms to allow good teaching and learning conditions.

In the last years, noise mapping in Europe is applied for different purposes like support for the national noise policy, spatial planning, comparison between sources or comparison with other annoyances like air quality.

Noise Level Legislation

The most important European document about the environmental noise is the well known **2002/49/EC Directive** (END), witch is transposed in Romanian legislation by HG nr.321/2005. Although the END does not impose limit values for noise levels, it recommends to Member States (MS) to establish their own limit levels accordingly to the documents of the WHO. Therefore, our country has established [1] the following limits for the noise produced by the road traffic:

Table 1. Limit noise levels in dB (A)

	Present permitted limit	**Target for 2012**
L_{den}	70	65
L_{night}	60	55

Assessment of Environmental Noise Levels

Environmental noise caused by road or railway traffic, by industrial activities or by aircraft, is assessed in the frame of legal regulations for different purposes:

- to assess the acceptability of new building developments in noisy areas, which is usually carried out by comparison of the assessed noise level against some limit value,
- to determine the nature and amount of noise abatement provisions (barriers, facade insulation) in case of excess of the limit value,
- to assess the acceptability of a new infrastructure (road, rail or airport) in the neighbourhood of residential areas, which again is usually carried out by comparison of the assessed noise level against some limit value,
- to assess the necessity of remedial action in the case of excessive existing noise in residential areas,
- to assess the compliance or excess of industrial noise levels against limit values laid down in the environmental permit (for industrial activities),
- to assess the number of annoyed residents or the surface of noise affected area in areas of natural beauty (this activity is also known as noise mapping) ,
- to assess the extension of the area where urban development is not acceptable without special attention to noise (this activity is also known as zoning).

For the above purposes the noise levels are usually assessed in the open, in front of the affected façade, where most often only the incident noise shall be regarded (reflections from the façade, which may lead to an increase of noise level due to interference, shall be ignored).

Measurement or calculation

Environmental noise levels can either be assessed by measurement or by calculation. Although a measured level (i.e. the reading of some measurement device) tends to be more convincing to the public than a calculated level (i.e. the output of some computer program) the preferred method is very often the calculation. The reasons for this preference are:

- the laborious assessment of the exact situation of the source (e.g. traffic flow) can be avoided,

- long term average weather conditions can be taken into account directly,
- information on the "typical" operation conditions of industrial activities can be taken into account directly,
- noise levels can be assessed even for future developments,
- possibly disturbing effects of "background" noise can be avoided,
- detailed information on the contributions of different partial sources can be assessed more easily, e.g. for industrial activities a source contribution analysis can be carried out, indicating the priority of the sources in case noise reduction is required,
- different scenarios can easily be synthesized in the case of noise action planning.

Prediction models for outdoor noise propagation

In spite of a long period of investigation and scientific contributions outdoor sound propagation is an area which is still not completely understood and still cannot be completely described analytically. In the seventies and eighties of the 20th century environmental noise became an issue in many member states. From excessive field studies into dose-response relationships it was found that the long term average, so-called *equivalent A-weighted noise level* gave good correlation with effects such as general annoyance. So, the need became clear to assess long term average noise levels with an acceptable degree of accuracy. For noise sources with a well defined long term behaviour it was shown that assessment through computation was more efficient, reproducible and accurate than assessment through measurement, which had been the common practice before. Thus there was a growing need for accurate computational tools that were capable of predicting noise levels from roads and railways. Such methods have been developed from the early seventies onward, and with the computer capabilities increasing have become common practice now.

Prediction methods for environmental noise from roads, rail and industry have existed and have been used for more than two decades now in several EU countries. However, a recent survey [2] concluded that none of the existing methods is completely adequate for future use as the common European standard and that there is a scope for significant improvement, even for the most advanced methods presently available. Recently, the Nordic countries have been involved in a large effort to improve their common, so-called *Nordic method* and indeed they have achieved considerable progress. The improved Nordic model represents the starting point for the work that is proposed in the HARMONOISE project [3].

In the HARMONOISE project a clear distinction is proposed between sources (road traffic, rail traffic sources) and propagation. It is the objective that one identical method shall be applied to describe the sound propagation and that the computational methods will only differ in source data. This will lead to a uniform description of the propagation attenuation effects which is irrespective of the source type, and then will make it possible to compare source data from one country to another.

Urban Noise Mapping Urgency

The END requirements regarding the urban noise mapping are very clear: all urban agglomerations having 250,000 inhabitants or more must dispose of a strategic noise map before 30 June 2007 and action plans before 18 July 2008. At the present time, Bucharest only has a first issue of a noise map (done in May 2007), the rest of 8 towns (Iaşi, Cluj, Timişoara, Constanța, Craiova, Galați, Braşov, Ploieşti) are still working on their maps.

Moreover, the EU requirements add: "*Authorities responsible for data collection in MS will have to report data from strategic noise maps and action plans to the Commission no later than six months after the deadlines set to deliver the noise maps and action plans*".

Example of Urban Noise Map

In order to find the simplest and most efficient urban noise assessment, for an objective determination of the measure in which the actual road traffic noise joins with the noise regulations, we have organized a study on the situation in our town, Braşov.

First, we observed that the specific feature of road traffic in our town is the fact that entire flow of heavy truck (internal and international road transport) has to pass through the town, because there is no ring road.

Then, we have found the *hot points* along the path of that traffic. So, we choose that one of these points might be the crossing between the streets *Aurel Vlaicu* and *Bdul. Gării* with *13 Decembrie.* The satellite view of this crossing is given in Fig.1.

Fig.1. Satellite view of the crossing

There we have organized the counting of passing vehicles, during the most agglomerated 3 hours in a day, for 3 days in a week. After that, the found number was transposed in *equivalent vehicle number*, using predicted transformation coefficients.
From the first step, we have decided to use a calculation method, based on a modern software. It was found to be the SoundPLAN 6.4 software [4]. The number of equivalent vehicles which passed by the crossing was taken as input data. There were counted 21,662 equivalent vehicles in 24 hours. The resulted map is presented in Fig.2.

As one can see in the map, the assessed noise level on the road axis is about 79 dB(A), and at the buildings façade about 69 dB(A) respectively. These levels are in correlation with the great number of heavy truck (TIR) passing by the crossing, consequence of the lack of a ring road for the entire town. The authors intend to repeat the noise monitoring after this heavy traffic will be eliminated, when the present construction of the town's ring road will be finished.

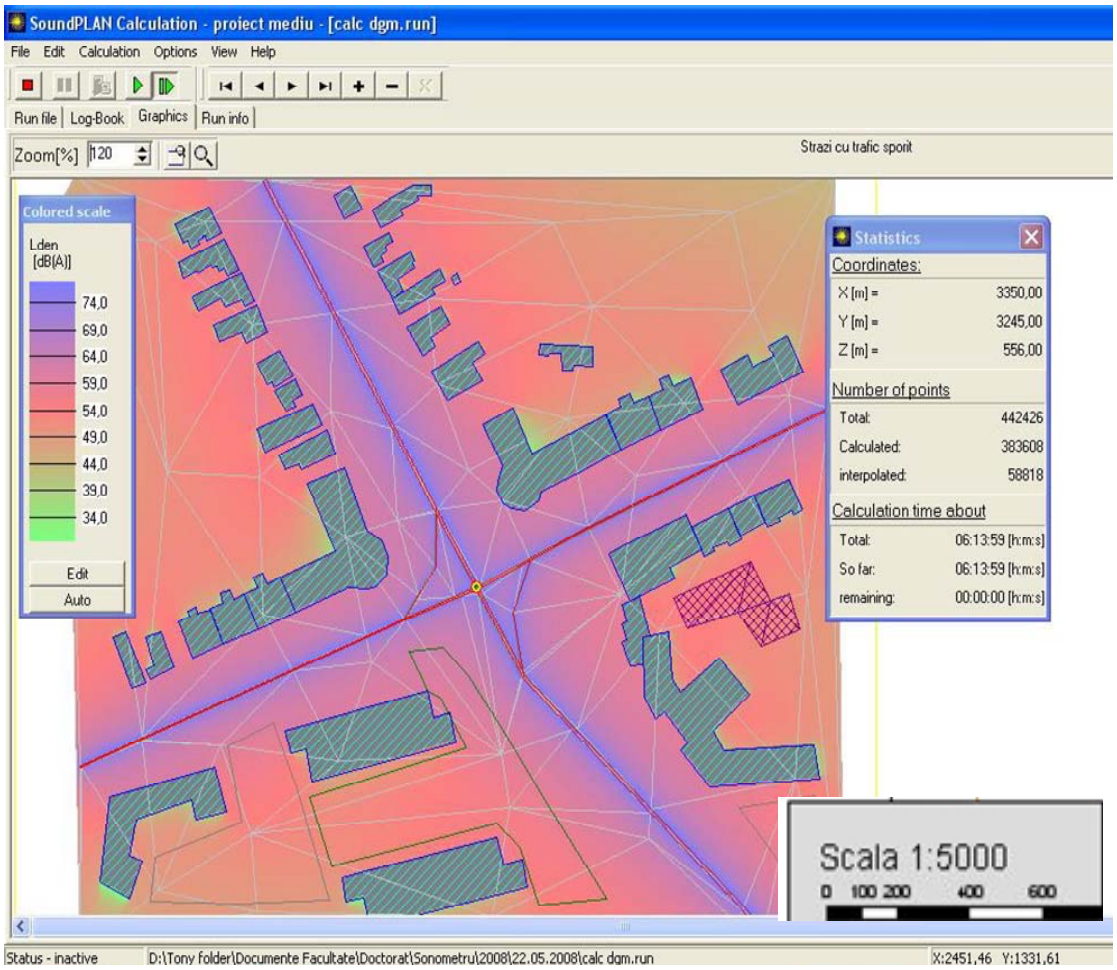

Fig.2. Resulted noise map

Conclusions

Noise mapping become a common practice in many countries. Nevertheless, because of the technical limits and of the use of different calculation methods, any noise mapping is a unique virtual experience.

In our country, the delay in this field must be and can be fast recovered. Our paper is only a sign that this problem is solvable, on one hand, and on the other hand, its resultant noise assessment shows a considerable exceed of the reasonable levels.

Besides, present paper confirms the validity of the calculation method in noise assessment. Indeed, after a few number of observations on the traffic volume, the rest of the work was made on the computer, with the aid of SoundPLAN 6.4 software.

Evidently, besides the traffic data, the calculus needed some other input data as: topographical map of the area, the elevation definition of the ground, the buildings contour and height, the exact specification of the road surface type etc.

References

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Evaluarea nivelului de zgomot în mediu urban

Rezumat

Pornind de la cele mai recente cercetări asupra zgomotului ambiental, conforme cu Directivele europene, în lucrare se prezintă metodele de cartare a zgomotului în mediu urban. În final, se dă un exemplu de hartă de zgomot ridicată într-o zonă cu trafic rutier aglomerat din Braşov.