NOISE MAPPING, A USEFUL TOOL FOR URBAN PLANNING – CASE STUDY, ALBA IULIA, ROMANIA

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ABSTRACT: The road traffic noise is the main source of noise pollution, posing a major threat to the quality of life. Noise mapping is a useful tool for urban planning, as it can be used to assess traffic management alternatives, in order to reduce the level of noise. This study aims to compare the results of noise modelling using a technique based on the traffic flow in a particular area with the results of noise measurements conducted in the same area and in the same period of time, in order to assess the accuracy of noise modelling.

Keywords: *noise pollution; noise mapping;*

1. Introduction

The noise from road traffic has become one of the most significant sources of noise pollution, affecting people's quality of life.

Noise is defined as a sound phenomenon comprised of irregular vibrations on frequency and amplitude, with various timbres, depending on its source.[1]

According to the European Environment Agency [2], noise pollution represents an increasing issue in Europe, and also in Romania, and the most people are not aware of its effects on their health. Noise pollution is a worldwide problem, both developed and developing countries being affected by it.

Noise pollution was acknowledged as a problem affecting the quality of life and health and, in the last years, efforts have been made to avoid, prevent and reduce the harmful effects of noise. Noise pollution is defined as the presence of sounds and vibrations at a level that disrupts people's activities and produces significant damage to the quality of life, to the human health and also to the environment.

Many people are not aware of the fact that noise pollution is a serious problem impacting their health. In accordance with World Health Organization (WHO), noise is the second environmental cause of health issues, after air pollution. [5]

In Romania, as worldwide, there is an increasing trend in the level of noise coming from urmab traffic. Studying of noise maps for different cities in the country revealed that sound levels are very high, much above the levels recommended by European regulations.

The main harmful effects related to noise are loss of concentration and sleep disturbance, but there may appear also other symptoms, such as: vertigo, balance difficulties and psychological effects, which affect respiration, hearing and the level of cortisol in blood. [3]

In accordance with the Law 121/2019 [4], the noise indicators applied in Romania for the preparation and revision of strategic noise mapping are: Day-evening-night noise indicator "Lden", which shows the overall annoyance, and Night noise indicator "Ln", which assesses the sleep disturbance caused by noise.

One of the main sources of noise pollution responsible for negative effects on human health is road traffic. Prolonged exposure to background noise is one of the

main causes that affect human health. Road traffic noise was associated with increased risk of ischemic heart disease.

Strategic noise maps are made to assess noise exposure for a given area, taking into account different sources of noise, or to make general predictions for that area. Noise maps for agglomerations shall put emphasis on the noise emitted by road, rail and air traffic and industrial areas.

The noise map usually laps over the plan of the area that requires mapping. One of the major advantages of noise maps is that they offer the possibility to accurately assess the adverse effects of road traffic, so that decision-makers could take proper measures in order to reduce the noise and minimize the impact. This is very important in planning activities, for analyzing different options before making a decision. [6]

When it comes to correctly interpreting road traffic noise, data processing software is very helpful. Usually, all programs are based on either sound measurements or predictions. [7]

External noise exposure is monitored by using two thresholds, which describe the ambient noise in relation with its effects on the population: an indicator for day, evening and night periods: "Lden" - 55 dB(A), which measures the noise discomfort associated with annoyance and a night noise indicator "Ln" - 50 dB, whose purpose is to assess sleep disturbance caused by noise.

2. Materials and methods

In Romania, the maximum admitted values for sound level in urban areas are regulated by SR 10009-2017 "Acoustic. Noise emission limits in the environment". The maximum admitted values for the level of continuous equivalent A weighted sound pressure „LAeq" (dB), at the at the edge of the sidewalk bordering the street are: for day time, between 07.00 a.m. and 11.00 p.m.: 70 dB and during night, between 11.00 p.m. and 07.00 a.m.: 60 dB [8].

The road traffic noise measurements were carried out using a Bruel & Kjaer - 2250 class I sound level meter, projected for standardized measurements of noise level.

As currently Romania doesn't have a method to calculate noise indicators, this study used one of the methods recommended by European Commission and by Romanian law to calculate noise indicators and to make strategic road traffic noise maps, respectively the French NMPB Routes method and the XPS 31-313 standard. For noise modelling, it was used the Predictor 7810 software, which which uses different standards and prediction methods including XPS 31-313 (the French standard).

3. Results

For this case study, that aimed to assess road traffic noise in Alba Iulia City, there were conducted sound measurements in one main intersection. The results obtained for the noise level were analyzed and interpreted and it was made a noise map for this intersection.

In order to determine and measure the level of noise, there were chosen the following measurement point: intersection: Vasile Goldis Way – Revolu iei 1989 Avenue.

The measurements were carried out in the 3th of October 2022, using a Bruel&Kjaer - 2250 sound level meter. The microphone of the sound level meter was placed at a height of 1,5 meters above the sidewalk bordering the street. The measurements were conducted under favorable weather conditions, with no strong wind or rainfall, and with a wind attenuator fitted to the microphone. The measurements were made during the day (07.00-19.00), in the evening (19.00-23.00) and during the night (23.00-07.00), local time. According to the Law 121/2019 regarding the assessment and management of environmental noise (Annex 1, letter e.), the day is 12 hours, the evening is 4 hours and the night is 8 hours.

The measurements were taken for 30 minutes in each of the three periods of time in the area chosen for the monitoring and assessment of road traffic noise.

The analysis of the results

For the intersection of streets: Vasile Goldis Way – Revoluţiei 1989 Avenue measuring results are presented in table 1.

The analysis of the measurements made revealed the fact that the measured values for the level of continuous equivalent A weighted sound pressure „LAeq" did not exceed the maximum limits allowed by law. One of the modern methods used for the assesment of urban noise pollution is noise mappig. In this study, the noise map was created considering the road traffic noise, by

Table 1 – The values obtained in the Vasile Goldis Way – Revoluţiei 1989 Avenue intersection

Measuring time (min.)	*Measured parameters*	*Measurement period 7:00-19:00 Time: 8:25-8:55*	*Measurement period 19:00-23:00 Time: 19:27-19:57*	*Measurement period 23:00-7:00 Time: 23:21-23:41*
30	L_{Aeq}	67.5 dB	61.4 dB	56.1 dB
	L_{Ceq}	76.3 dB	69.8 dB	67.5 dB
	L_{Cpeak}	88.7 dB	81.2 dB	74.5 dB
	$L_{AFmax.}$	68.2 dB	62.3 dB	59.7 dB
	$L_{AFmin.}$	65.3 dB	58.2 dB	53.3 dB

In the figure 1, there are presented the results of the measurements of the equivalent continuous sound level, compared to the maximum allowed limits allowed by the law.

using the Predictor 7810 program. Since currently Romania does not have a method to calculate noise indicators and to make strategic road traffic noise maps, one of the

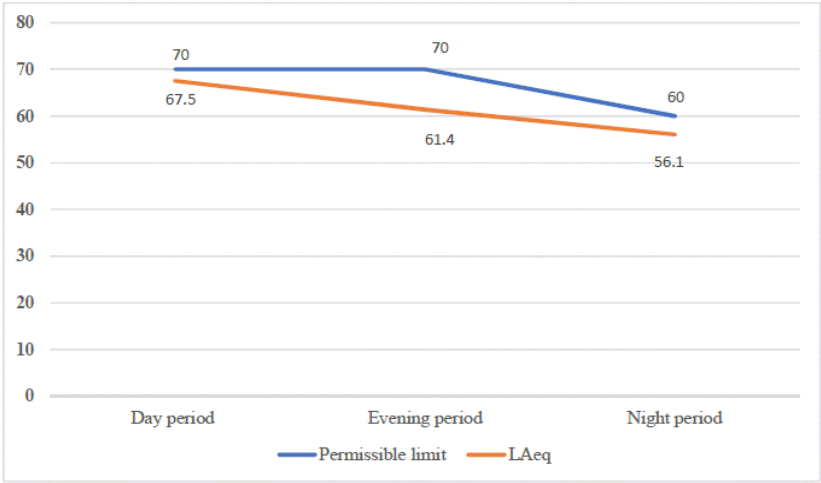

Figure 1 – The values of LAeq measured in the Vasile Goldis Way – Revoluţiei 1989 Avenue intersection, during the day, evening and night

methods recommended by the European Commission was used, namely the French NMPB Routes method and the XPS 31- 313.

The noise indicators used in the assessment and drawing of noise map were: day-evening-night noise indicator Lden (dB), day-noise indicator Lday (dB), evening-noise indicator Levening (dB), night-time noise indicator Lnight (dB) and equivalent continuous sound level A-weighted LAeq (dB).

In order to create a noise map, it was developed a digitalized model, named base map, which covers the area subjected to noise mapping. Besides the base map, it was necessary to collect further information, such as: the type and number of vehicles from road traffic, their speed, the type of traffic flow, the type of road surface, information about the buildings. The area chosen for noise mapping is the Vasile Goldis Way – Revolu iei 1989 Avenue intersection.

The traffic parameters were estimated based on the data collected by observation and counting during the measurements of noise indicators and they are:

- the number and type of vehicles:
  - Revoluţiei 1989 Avenue - light motor vehicles < 3500 kg = 1064 day, 382 evening, 186 - night, heavy vehicles > 3500 kg = 54 day, 23 evening, 11 - night
  - Vasile Goldiş Way – one-way street - light motor vehicles < 3500 kg = 823 day, 167 evening, 123 - night, heavy vehicles > 3500 kg = 34 day, 21 evening, 13 - night
  - Vasile Goldiş Way – two-way street - light motor vehicles < 3500 kg = 225 day, 122 evening, 48 - night, heavy vehicles > 3500 kg = 21 day, 12 evening, 7 - night
- the speed of the vehicles: 40 km/hour (light motor vehicles); 30 km/hour (heavy vehicles);
- road slope: flat;
- type of road surface: smooth asphalt;
- type of traffic flow: continuous-pulsatile flow, where vehicles are in a transient state, both through accelerations and decelerations, with variations in flow over time intervals, with irregular concentrations of cars on the road section,

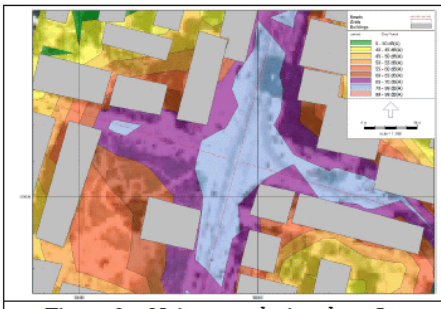

Figure 2 – Noise map during day - L_{day}

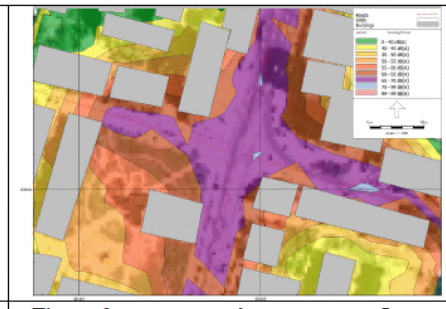

Figure 3 – Noise map during evening - $L_{evening}$

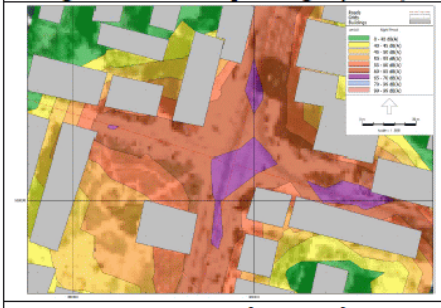

Figure 4 – Noise map during night - L_{night}

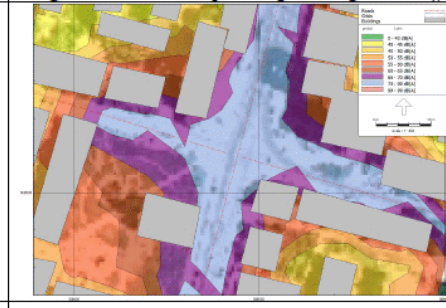

Figure 5 – Noise map day-evening-night - L_{den}

flow found on main roads, in intersections with pedestrian crossings.
- information about the buildings from the area:
  - residential buildings
  - commercial buildings: supermarket, oil station
  - the height of the buildings: 7-30 meters
- Coordinate system: Stereo70.

3. Conclusions

Noise mapping are a very useful tool for the assessment of road traffic noise.

Even though in this study the road traffic data were roughly estimated, by counting the number of vehicles for 30 minutes in each measurement period, the results obtained through modelling were similar to those obtained from measurements.

The accuracy of noise level modelling can be improved by systematic counting during longer periods of time and by using computerized counting systems.

The results of noise modelling should be validated by noise measurements. Noise maps may be used as tools for simulating the effectiveness of different traffic management measures prior to their implementation.

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