

STUDY OF ROAD TRAFFIC NOISE POLLUTION IN AIUD CITY, ROMANIA

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ABSTRACT: *Noise pollution represents a topical and common issue, especially in agglomerations and it is caused mainly by road traffic, rail traffic, industrial and commercial activities, but it can be generated also by other human activities, which, cumulated, represent the environmental noise that may induce harmful effects on human health and welfare. Road traffic is considered to be the main source of noise pollution, due to the steady growth of the number of vehicles that pass the public roads, correlated, in some areas, with the poorly developed infrastructure. The number of persons exposed to noise exceeding the limit values is constantly increasing, although in many countries there are already in force noise-reduction measures. Prolonged exposure to high level noise may cause a series of health problems, such as: sleep disturbance, mental problems, hear loss, cardiovascular diseases, stress etc. The level of exposure to road traffic noise depends on a series of factors, among which the most important are: the type of road, the traffic intensity, the noise reduction measures, the type of building, the characteristics of the vehicles and the behavior of drivers. The reduction of road traffic noise ranks high on the authorities' agenda worldwide. This issue is common in many agglomerations from Romania too, because of the increased number of vehicles, the low renewal rate of cars and the poorly developed infrastructure, which is not able to respond to increasing traffic. This study aimed to identify the noise level in different areas of Aiud city, Alba county, located nearby National Road 1, which crosses the city.*

Key words: *traffic noise; noise pollution; sound level;*

Introduction

Environmental noise is defined by Law 121/2019 regarding the assessment and management of environmental noise as being an unwanted or harmful outdoor sound created by human activities, including noise generated by means of transport, road traffic, rail traffic, air traffic and noise emitted from sites of industrial activities. In accordance with this law, no later than 30 June 2022, there must be made and approved noise maps for the previous year for all agglomerations, major roads, major railways and major airports; also, these maps must be reviewed or revised at least every five years. In addition, this law specifies that no later than 18 July 2023 there must be drawn up

action plans designed to manage the noise and its effects, including, if necessary, noise reduction measures. These plans shall be reviewed and, if necessary, revised in case of major change affecting the existing noise situation and at least every five years after the date of their approval, for all agglomerations, major roads, major railways and major airports.

Noise can be defined as an unwanted or excessive sound or as a secondary product of our current lifestyle. Noise is perceived as one of the factors which interfere with sleep, work and recreation and a prolonged exposure to noise often leads to physical and psychological damage, reduced quality of life or simply disruption of daily activities. Noise is perceived by human beings

physiologically, by sensing the vibrations of sound waves in the subconscious, while the psychological perception consists in focusing attention on that noise, without intuitive ignoring. Noise creates communication problems and leads to high level of stress and associated behavioral effects on health. The vibrations induced by the resonance of traffic noise may have negative effects on the structures of old or improperly built buildings, common in many developing countries, which are the first to collapse if they are placed near crowded roads. [2],[5].

The environmental noise level is steadily increasing in urban areas, mainly due to the intensification of traffic and industrial activities.

The people exposure to road traffic noise is due to: the circulation of vehicles, the friction between the tires and the road surface as well as the road construction and maintenance activities. The noise produced by vehicles is caused by the engine, transmission, exhaust and suspension, reaching its highest values during acceleration, improperly braking, on rugged roads, but also on crowded roads. Inappropriate maintenance of the vehicle is a factor that contributes to an increased level of noise. The noise produced by the friction between the tires and the surface has a significant contribution to general traffic noise, its level depending on the type and the condition of both the tires and the road. The level of noise usually increases at high speeds and at sudden braking. Road construction and maintenance usually implies the use of heavy equipment and, even though these activities can be intermittent and localized, they contribute to a high level of noise while the equipment is functioning. The physical characteristics of the road surface play an important role in the noise pollution, as the properly maintained roads are responsible for less noise than deteriorated roads. Also, the driver behavior may have a contribution on the level of traffic noise. Usually, heavy vehicles, such as

trucks, are noisier than small cars, because they have a bigger tire-road surface contact. Poorly maintained vehicles, such as those with incomplete exhaust systems or worn brakes, tend to be noisier than properly maintained vehicles. In addition, some types of tires, such as off-road or winter tires, are extremely noisy. Noise pollution is a significant environmental issue in the cities with a fast infrastructure development and it is becoming a serious problem these days because of faulty urban planning, as houses and other commercial and community facilities are placed near main roads for accessibility, but no buffer areas or adequate sound insulation facilities are built. [2],[3].

Meteorological conditions such as temperature, humidity, wind speed and predominant wind direction, but also topographic conditions, can influence the propagation of sound.

Road traffic related noise can have a detrimental effect on many animal species which live near the roads, because they tend to leave the area. The roads interfere with the migration of different species and often lead to an increase in the mortality rate of the animals living near the communication routes. Noise interfere with migration, communication and reproduction of the wildlife.

Propagation of traffic noise is influenced by the nature and features of the obstacles created by man, which totally or partially block the sound route, reducing the level of noise. Among these, there are: forested areas, big buildings, houses, roadbeds, safety barriers, retaining walls and noise barriers. There are more paths of the sound when meeting a noise influencing barrier. The reflection of the sound from the noise barrier located on one side of the road reduces the noise behind the barrier, but it can increase the noise on the opposite part of the road, especially when there is not applied an absorbing surface on the barrier. The diffraction of the sound above the superior part of the barrier decreases the level of

noise, compared to the direct path of the sound. The transmission of the sound through the barrier requires the use of noise controlling barriers, which are able to ensure a loss of transmission of 30 dB. [2].

The road traffic related noise may influence the value of the residences in the area, as the price of houses exposed to high levels of noise is lower than the price of similar houses located in quieter areas.

Other negative effects of noise on human health are: noise induced hearing deficiency and communication interferences. Hearing impairments may be accompanied by tinnitus (continuous noise in the ear). Hearing impairments caused by professional noise depend on the average value of the equivalent sound level in eight hours, number of exposure years and individual susceptibility. Men and women have equal risk for noise-induced hearing impairments. The main social consequence of hearing impairments is the incapacity of understanding speech in daily life and this is considered to be a severe social disability. Construction workers working around heavy equipment are particularly exposed to noise, being the most exposed to hearing impairments [5].

Noise pollution is directly correlated with the human performance. The relation between traffic noise and its effect on human work efficiency outlines the fact that noise affects work performance, no matter the type of work [3].

In order to reduce the level of noise, there must be adopted a series of measures, such as: the construction of noise barriers, the use of sound insulation in buildings, traffic management, the renewal of car fleet, the construction of protective curtains etc.

Noise barriers are usually made of mounds of earth or walls of wood, metal or concrete that form a fairly solid obstacle. The topsoil is also an option as it tends to absorb and moderate noise, while materials such as concrete tend to reflect it. Plantations of trees and shrubs also contribute to the visual

appearance, providing a psychological benefit [2].

Material and methods

In order to measure the level of road traffic noise, there were chosen 4 monitoring points, located as it follows:

-Point 1: at the intersection of Tudor Vladimirescu Street, National Road E81 and Valea Lupului Street, near the house number 68.

-Point 2: in the Aiud City Belt area, at the intersection of Calea Morii Street and Stadionului Street, near the house number 26

-Point 3: nearby Penny Supermarket, at the intersection of Morii Street and Transilvaniei Street, near the house number 76

-Point 4: in front of the town hall of Aiud City, on No. 1 Cuza Vodă Street, near the Medieval Citadel.

The noise measurements were carried out in November 2019, in favorable weather conditions, using a Bruel&Kjaer 2250 sound level meter.

The sound level meter was placed on a stand, with its microphone at a height of 1.2 m, at the pavement's border, near the road and the measuring time was 20-30 minutes in each point.

The results were compared to maximum admitted values for outdoor noise level, according to Romanian Standard SR 10009/2017 - Acoustics. Maximum permissible ambient noise levels [1].

There were measured the following parameters:

- **L_{AeqT}** – the level of continuous equivalent sound pressure, measured in decibels defined by the following formula:

$$L_{AeqT} = 10 \lg \left[\frac{1}{T} \int_T p_A^2(t) / p_0^2 dt \right]$$

where:

$p_A(t)$ is the instantaneous sound pressure A, time-weighted during functioning time t ;

p_0 is the reference sound pressure ($=20\mu Pa$);

- LAF10T – the level of sound pressure, time weighted and frequency weighted, measured in decibels, exceeded in 10% of the analysis time;

- LAF90T – the level of sound pressure, time weighted and frequency weighted, measured in decibels, exceeded in 90% of the analysis time;

- LCPeak – the level of peak sound pressure during the analysis time;

- LAFmax - is the A-weighted, fast response, maximum sound level;

- LAFmin - is the A-weighted, fast response, minimum sound level;

Db. If the external source of noise is represented by road traffic and the maximum admitted limit at the boundary of the property cannot be respected because of technical issues, there should be adopted measures to respect the admitted limit at the most exposed side of the building, which is: - LAeqT – 50 dB [6].

The results obtained from measuring the noise parameters in the 4 locations described above are presented below.

The results of noise level in Point 1 are presented in table 1:

The measurements carried out in the first

Table 1. The results obtained in Point 1, at the intersection of Tudor Vladimirescu Street and Valea Lupului Street

Measured parameters	Result (dB)	Result (dB)	Result (dB)	Noise limit (dB) (according to SR 10009/2017)
L _{AeqT} (dB)	72,5	74,9	76	70
L _{Cpeak} (dB)	108,5	104,5	105,5	-
L _{AF10T}	75,5	78,4	80,1	80
L _{AF90T}	61,9	65,4	52,8	-

For the assessment of noise level, it was used the weighting in A frequency. For the measurement of peak sound pressure level, it was used the weighting in C frequency.

Results and dicussions

According to Romanian Standard SR 10009/2017, the maximum admitted values for outdoor noise level related to road traffic, measured at the pavement's border, near the road, for connecting streets, are: the level of continuous equivalent sound pressure A - LAeqT-70 Db; the level of sound pressure frequency A weighted and time F weighted, exceeded in 10% of time T-LAF10T-80 dB.

According to SR 10009/2017, the maximum admitted values for outdoor road traffic noise level, measured at the boundary of fenced terrains (yards), with residential use and containing buildings with maximum two levels are: the level of continuous equivalent sound pressure A - LAeqT – 60

point, at the intersection of Tudor Vladimirescu Street and Valea Lupului Street, revealed that the level of continuous equivalent sound pressure exceeded the maximum admitted limit for outdoor noise during all measurements conducted. Taking into account the fact that the National Road crosses by the residential area, in which the front side of the houses is placed along the road, it can be concluded that neither the maximum admitted value of noise at the most exposed side of the buildings (50 Db) is respected.

The results of noise level in Point 2 – the intersection of Calea Morii Street and Stadionului Street - are presented in table 2.

The measurements carried out in the second point, at the intersection of Calea Morii Street and Stadionului Street, revealed that the level of continuous equivalent sound pressure exceeded the maximum admitted limit for outdoor noise during all measurements conducted.

Table 2. The results obtained in Point 2, at the intersection of Calea Morii Street and Stadionului Street

Measured parameters	Result (dB)	Result (dB)	Result (dB)	Noise limit (dB) (according to SR 10009/2017)
L_{AeqT} (dB)	73,54	73	71	70
L_{Cpeak} (dB)	118	112,7	112,4	-
L_{AF10T}	76,6	76,5	74,7	80
L_{AF90T}	57,8	60,1	49,6	-
L_{AFmax}	96	92,8	91,7	-
L_{AFmin}	42,6	47,3	40	-
The period of measurement	08:00-08:27	13:30-13:52	22:09-22:33	

Taking into account the fact that the National Road crosses by the residential area, in which the front side of the houses is placed along the road, it can be concluded that neither the maximum admitted value of noise at the most exposed side of the buildings (50 dB) is respected and, moreover, in 90% of the measuring time the noise level was quite high, as its value was between 49,6 and 60,1 dB.

The results of noise level in Point 3 – the intersection of Calea Morii Street and Transilvaniei Street are presented in table 3.

equivalent sound pressure exceeded the maximum admitted limit for outdoor noise for 2nd category streets (connecting streets) with 1,8-2,5 dB.

The results of noise level in Point 4 – in the front of the city hall (Cuza Vodă Street) - are presented in table 4.

By analyzing the data obtained in Point 4, in front of the city hall (Cuza Vodă Street), it can be noticed that the level of continuous equivalent sound pressure exceeded the maximum admitted limit for outdoor noise for 2nd category streets

Table 3. The results obtained in Point 3, at the intersection of Calea Morii Street and Transilvaniei Street

Measured parameters	Result (dB)	Result (dB)	Result (dB)	Noise limit (dB) (according to SR 10009/2017)
L_{AeqT} (dB)	71,8	72,5	69,8	70
L_{Cpeak} (dB)	103,9	104,8	104,6	-
L_{AF10T}	74,7	75,7	72,7	80
L_{AF90T}	65,3	65,5	59,3	-
L_{AFmax}	84,5	88,6	90,8	-
L_{AFmin}	57,2	58,6	51,1	-
The period of measurement	08:32-08:55	14:05-14:27	22:38-23:01	

By analyzing the data obtained in the third point, at the intersection of Calea Morii Street and Transilvaniei Street, it can be noticed that, in two of the three measurements made, the level of continuous

(connecting streets) with 7,8 dB only in one of the two measurements made; this happened due to the lower intensity of traffic in the area, as heavy traffic is diverted on the city belt.

Table 4. The results obtained in Point 4, in front of the city hall, Cuza Vodă Street

Measured parameters	Result (dB)	Result (dB)	Result (dB)	Noise limit (dB) (according to SR 10009/2017)
L_{AeqT} (dB)	65,3	72,5	65,1	70
L_{Cpeak} (dB)	102,2	104,8	97,6	-
L_{AF10T}	68,9	75,7	65,1	80
L_{AF90T}	55,5	65,5	48,8	-
L_{AFmax}	81,1	88,6	81,1	-
L_{AFmin}	47,7	58,6	39,9	-
The period of measurement	09:02-09:27	14:05-14:27	23:10-23:31	

Conclusions

The measurement of road traffic noise level revealed the fact that the maximum admitted value for continuous equivalent sound pressure, regulated by SR 10009/2017, has been exceeded on almost all streets

monitored in this study.

Considering the fact that the streets cross residential areas, that have even stricter noise limits, according to SR 10009/2017, local authorities should take immediate measures to reduce the noise level related to road traffic.

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