Noise pollution generated by road traffic in Bucharest

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ABSTRACT: Through the observations recorded by the Environmental Research Centre, University of Bucharest, there can be noticed a significant level of noise pollution in Bucharest, caused mainly by the increase of the generating sources and the lack of antiphonic protection measures. The measurements realized in different spots (intense traffic streets, industrial platforms, residential areas, market places) indicated that the highest values of the continuous equivalent acoustic level (Leq) appear on the 1st and 2nd category roads, where the heavy traffic is intense. The recorded Leq values were between 65 - 75 dB (A) for the 1st and 2nd category roads, frequently overpassing the maximum admitted level (70 dB(A)). In order to reduce the noise pollution it is necessary to diminish the noise level at the sources and to apply antiphonic protection measures (rehabilitation of forest protection belts, of the roads and tram lines, deviation of heavy traffic etc.).

RÉSUMÉ : Par les observations enregistrées par le Centre de Recherche Environnemental de l'Université de Bucarest, on note un niveau significatif de nuisances sonores à Bucarest, causées principalement par l'augmentation des sources de production et le manque de mesures de protection antiphoniques. Les mesures effectuées dans divers lieux (des rues à forte circulation, des plates-formes industrielles, des secteurs résidentiels, des places de marché) ont indiqué que les valeurs les plus hautes du niveau équivalent acoustique (Leq) continu apparaissent sur les routes de 1ère et 2ème catégorie, où le trafic lourd est intense. Les valeurs de Leq enregistrées étaient entre 65 - 75 dB (A) pour les routes de 1ère et 2ème catégorie, dépassant fréquemment le niveau maximum admis (70 dB (A)). Pour réduire les nuisances sonores, il est nécessaire de diminuer le niveau sonore aux sources et d'appliquer des mesures de protection antiphoniques (réhabilitation des ceintures de protection forestière, des routes et des lignes de tramway, déviation du trafic lourd, etc.).

INTRODUCTION

The sound represents a sinusoidal variation of the air pressure, with a well defined frequency, that is transmitted in the atmosphere at variable speed. The noise is composed of a random combination of a large number of sounds (Hertig, 1999), without harmony (Larousse, 1999), which can harm the organ of hearing (Ursoniu, Dumitrescu, 1976). The perception of noise depends to the sound frequency and level (Mănescu, 1986), the increment being situated between 10-135 dB(A) and 2-19 kHz (Hertig, 1999).

Noise pollution can be defined as unwanted or offensive sounds that unreasonably intrude into our daily activities (EPA, 1974). The noise pollution is caused by high or medium intensity noise, which affects the health of the population and the various human activities.

The noise pollution is a characteristic problem of contemporary urban settlements, that comprise a large and various number of noise-generating sources (road, rail or air traffic, industrial platforms, marketplaces etc.). In consequence, the medium level of the sound often overpasses the maximum limits imposed by the regulations (STAS, ISO) and the technical solutions to diminish the impact are very expensive (antiphonic panels etc.) or very hard to be applied (increasing the surface of green spaces, intervention at the sound levels etc.).

At national level, the responsibility for solving the problems related to noise pollution is held by the Ministry of Agriculture, Forests, Waters and Environmental Protection and Ministry of Heath and Family. In Bucharest, the Environmental Protection Agency and the departments of Urban Ecology within the Bucharest and departmental City Halls hold the responsibility for the control and monitoring of the noise pollution.

In Romania, the Ministry of Health (1997) established the hygiene specifications and recommendations regarding the population's habitat, one of these regulations referring at the noise pollution. In this direction, there can be mentioned the standard specifications that establish:

– separation of the noise-generating sources of the neighborhood areas by sanitary protection areas;
– the continuous equivalent acoustic level (Leq), measured at 3 m distance of the exterior wall of the house, at 1,5 m height from the soil, must not be higher than 50 dB(A) during the day and 40 dB(A) during the night (between 22.00-6.00). Inside the houses, the Leq measured with the windows closed, must not be higher than 35 dB(A) during the day and 25 dB(A) during the night.

The actual standard specifications (STAS) establish the Leq limits depending on the noise generating source type and characteristics, the methods for choosing the measurements points, the homologated instruments etc.

The City of Bucharest is characterized by a high level of noise pollution, reflected onto the inner and outer habitat comfort and the health state of the population. This critical situation, caused by the high levels of the sound recorded in different spots in Bucharest, exists due to the increase of number of generating sources (especially road traffic) and the lack or degradation of the protection measures (green spaces). Also, the public roads network is insufficient reported to the traffic, the poor modernization of the roads (high proportion of un-asphalted roads, with road stone or gravel or with degraded asphalt) and the traffic management is inadequate.

MEASURING METHODS

For the assessment of the noise pollution determined by the road traffic in Bucharest, there were used the data obtained from the measurements recorded by the Centre for Environmental Research and Impact Studies in the periods March - September 2002 and March - September 2003.

The measurements taken by the Centre for Environmental Research and Impact Studies were realized with the *Integrator averaging and octave filter sound meter type 2 CR:274 with a type MK 202A microphone*. This instrument is part of the *Integrate numeric instruments for measuring the sound level based on medium impulses* category. The instrument is in accordance with the Romanian standards (*SR ISO 1996-1 – Acoustics – Characterizing and measuring the environment noise: basics procedures*).

For the noise level recordings, the following options of the instrument were used:

- weighting for dB(A).
- range between 50-110 dB(A), it was moved in the <75 dB(A) position when low sound levels were recorded.
- I (intermediary) response.
- no frequency filters were activated.

Before the recordings, the sound meter was calibrated with the *CR:513A type Sound Level Calibrator*, places on top of the microphone. In order to attenuate the wind influences, a special sponge was placed on the top of the microphone.

The sound level was recorded in 30 spots, in areas with different functions, where the main source of noise was the road traffic (industrial platforms Policolor, Panduri-Viilor and Orhideelor-Grivița, residential areas, construction sites, marketplaces etc.). New urban arrangements will be realized in these areas, according to the Zone Urban Plans, so the sound recordings are necessary for the assessment of the current situation and for taking the solutions to solve the noise problem. The measurement spots were as it follows: six on the Theodor Pallady Blvd, three in Văcărești Lake area, one on the București-Pitești Highway, five in the area of finalization of the main traffic ring - Olteniței-Brâncoveanu, five in the Obor commercial area, five in the Main Railway Station and five in the Panduri-Viilor area (CCMESI, 2002-2003).

The measurements were made in various meteorological conditions, emphasizing the importance of weather in assessing the noise pollution. The measurement spots were located in the neighborhood of the main noise-generating sources, in order to avoid the alteration on the noise level.

The measurements were taken accordingly to the SR ISO-1996 - 1, 2 and 3 standard regulations, and the values were reported to the STAS 10144-80 and STAS 11336/1, 2 - 80 standard regulations.

The location of the measurement spots was established in order to avoid and minimize the errors. The measurements were realized at more than 4 m distance from any obstacle that could reflect the sound. During the measurements, the instrument was held still and directed to the main source of noise (according to the SR ISO 1996-1 standard regulation).

The measurements consisted of the 30 minutes average sound level and highest sound level between 8.00-20.00. During the sound measurements, road and tram traffic monitoring was realized, as this source of noise was considered the most important. Also mapping the road characteristics (type of lining, degradation, length, width, circulation signs and semaphores) was realized. The influence of the weather characteristics on the Leq was observed (air temperature humidity, wind speed and direction).

MEASUREMENTS ANALYSIS

In 1994, NSW Road Traffic Noise Taskforce mentioned that the road traffic noise became a major problem in the urban areas, because:

- the territorial planning didn't realize a correlation of the traffic management and the human habitat conditions.
- the population begun to opt more and more for individual road transportation (personal cars), minimizing the common transportation;
- the road traffic significantly increased, but the technical conditions of the roads remained the same (lining, dimensions, signs etc.);
- the regulations for controlling the road traffic noise are hard to apply due to the high costs and the lack of collaboration between the responsible institutions;
- the population awareness on the noise effects and the possibilities to minimize them are extremely low.

In Bucharest, the highest sound levels are determined by the road and tramway traffic, the other local sources just emphasizing the stress caused by the main sources (Patroescu et al. 2002).

The impact of the road traffic noise varies with the street characteristics (lining, declination, road humidity etc.), the urban protection measures, the type of the surrounding buildings, the type of vehicles and the behavior of the drivers (Samaras & Sorensen, 1998).

It was noticed that the highest levels of sound appear on the 1st and 2nd category roads, where the general traffic is intense and the heavy traffic is very important (Table 1, Fig. 1). So, on the 1st and 2nd category roads, the Leq values were between 63.4 dB(A) on the Theodor Pallady Blvd and 75.1 dB(A) on the Calea Griviţei, the highest frequency of the recordings varying between 70 and 73 dB(A). During the day, the highest values are recorded between 11.00-15.00, when the heavy traffic that serve the industrial and commercial units is very intense (Fig. 2). The Leq level daily variations are related to the general traffic only if the heavy traffic is reduced.

Table 1 – Spatial dynamics of the Leq level in Bucharest

Measurement point	Average	Minimum	Hour	Maximum	Hour
Şoseaua Olteniţei	70,9	67	14.00	73,8	11.00
Şoseaua Giurgiului	70	66,2	9.00	75,3	13.30
Bd. Pieptănari	64,5	59,8	19.00	67	13.30
Bd. Vasile Milea	74,3	69,8	19.30	78,1	11.30
Intersecţie Răzoare	73,8	69,7	8.00	76,5	11.30
Piaţa Chirigiu	67,8	64,6	12.30	72,3	14.00
Intersecţie Piaţa Sudului	65,7	62,3	19.30	68,7	15.30
Şoseaua Vitan Bârzeşti	74,1	71,1	19.30	76,6	15.00
Splaiul Unirii (Pod M.Bravu)	72,2	69,9	9.30	74,1	13.00
Şoseaua Ştefan cel Mare	71,3	69,4	13.00	71,8	10.00
Şoseaua Mihai Bravu	72,4	69,2	17.00	73,9	14.30
Calea Moşilor	71,4	66,2	8.30	74,2	14.30
Şoseaua Colentina	69,4	64,6	11.00	74,2	11.30
Str. Turmelor	66,5	62,2	17.00	70,4	16.00
Calea Griviţei	75,1	72,6	11.30	77,3	10.00
Str. Buzeşti	75,6	61,2	8.00	75,6	13.30
Calea Giuleşti	69,8	57,8	8.00	75,4	11.30
Bd. Constantin Noica	71,4	65,1	8.00	75,8	15.00
Intersecţia Gara de Nord	71	68,5	11.00	73,5	12.30
Intrare Autostradă Bucureşti Piteşti	76,2	67,3	20.00	80,4	13.00
Bd.Pallady	63,4	59,2	8.00	66	14.30

On the Şoseaua Giurgiului (nearby the entrance of the Evangelic Cemetery), the Leq levels were between 66,2 and 75,3 dB(A), the average value being 70 dB(A), mentioning that the general traffic overpass 2500 vehicles per hour. A similar situation is recorded on the Şoseaua Olteniţei (nearby the Constantin Brâncoveanu Metro Station), where the Leq levels vary between 67 and 73,8 dB(A) and the higher values are determined by the larger number of heavy vehicles and tramways that transit the area. Road modernization activities were carried out on the Şoseaua Olteniţei, that determined the increase of the Leq values with approx. 5 dB(A). The influence of the road modernization activities on the sound levels increase was observed also during the measurements on Calea Giuleşti and Theodor Pallady Blvd. On the Theodor Pallady Blvd, high values of the Leq were recorded (over 70 dB(A)), due to intense heavy traffic (900 vehicles per hour) and to the construction of the new metro line between Nicolae Grigorescu - Policolor.

On the Calea Griviţei, the high values (72.6 and 76.6 dB(A)) are determined by the intense general traffic (over 2000 vehicles per hour), of which the heavy traffic (40 trucks and 6 trailers per hour) and the rail traffic (Basarab and Main Railway Station are situated nearby) have an important contribution. It means that the maximum permitted limit for this road category (70 dB(A)) is always over passed during the day.

The increase of the Leq levels is also related to the traffic structure, the heavy traffic always determining it (Fig. 3). On most of the 1st and 2nd category roads, where the heavy traffic is intense (Şoseaua Orhideelor, Calea Griviţei, Bd. Vasile Milea, Şoseaua Ştefan cel Mare, Şoseaua Mihai Bravu, Şoseaua Giurgiului, Şoseaua Olteniţei etc.), surpasses of the maximum permitted limits frequently appear. On the roads where the heavy traffic has a low intensity, the Leq dynamics is determined by the variations of the total traffic values (Fig. 4).

Leq variations related to the road traffic dynamics is emphasized by the fact that on the less traffic roads, such as Theodor Pallady Blvd, Pieptănari Blvd, the values significantly decrease. On the Pieptănari Blvd, the Leq values were between 59,8 and 67 dB(A), the highest values being recorded between 12.00-15.00; it means that Pieptănari Blvd isn't a binding route between the residential and industrial areas.

For the street with low traffic values, the Leq values were generally under 65 dB(A) (Stoian Militaru,. Mărţişorului, Turmelor streets).

For the noise impact assessment of the impact of the Bucureşti-Constanţa Highway penetration (through Theodor Pallady Blvd) and Bucureşti-Braşov Highway penetration (through St. Petricani) comparative measurements with the Bucureşti-Piteşti Highway penetration were realized. The Leq values between 67,3 and 80,4 dB(A) and the average of 74,5 dB(A), emphasizes the noise pollution problems and the influence of the road traffic sources.

Dynamic of Leq in different areas of Bucharest city

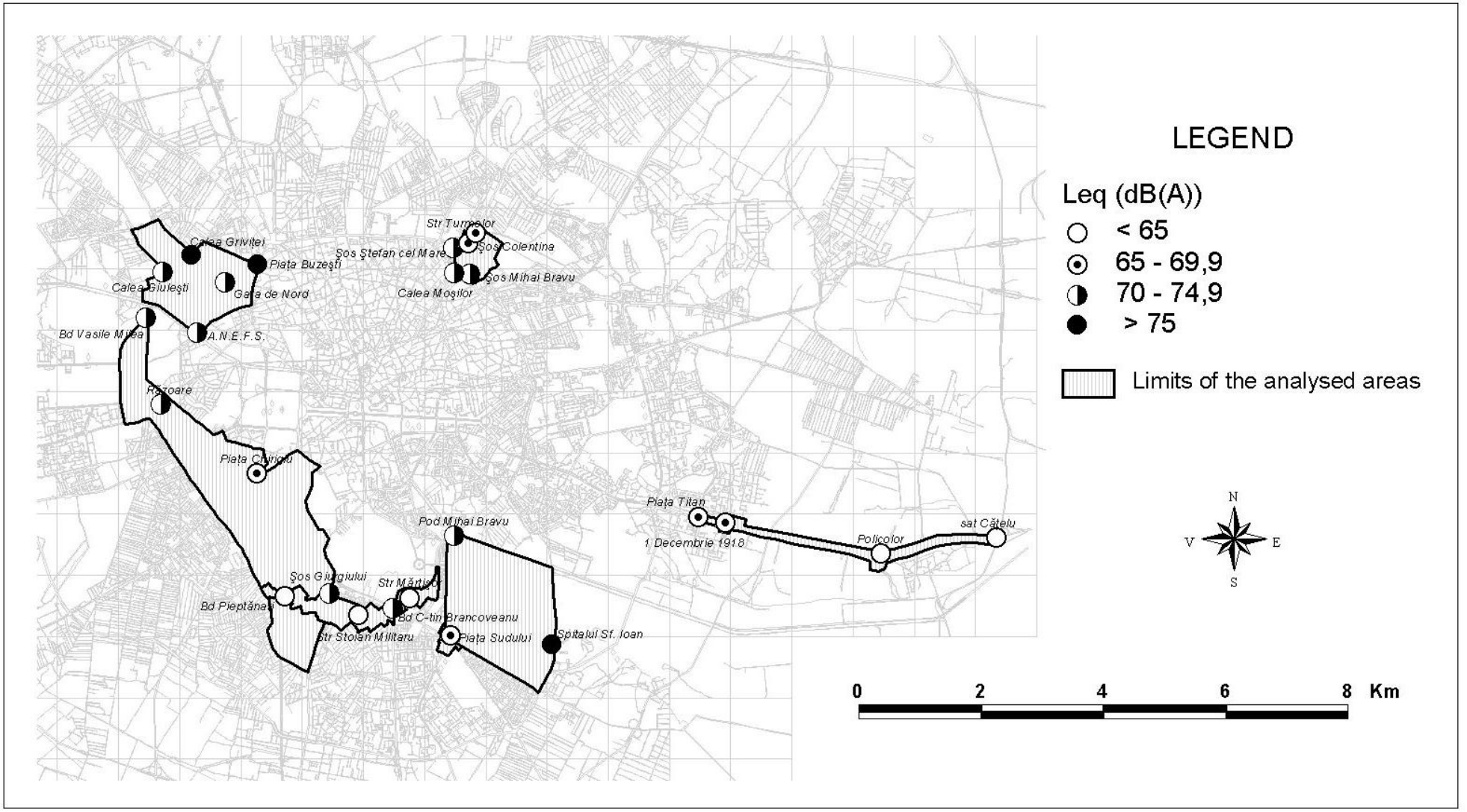

Figure 1. Dynamic of Leq in Bucharest

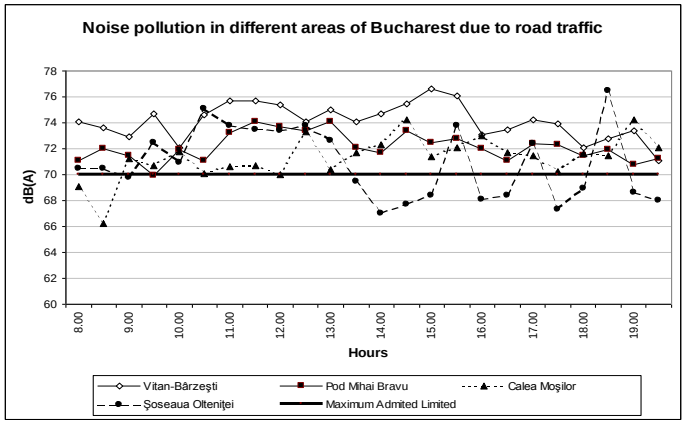

Figure 2. Noise pollution in different areas of Bucharest due to traffic

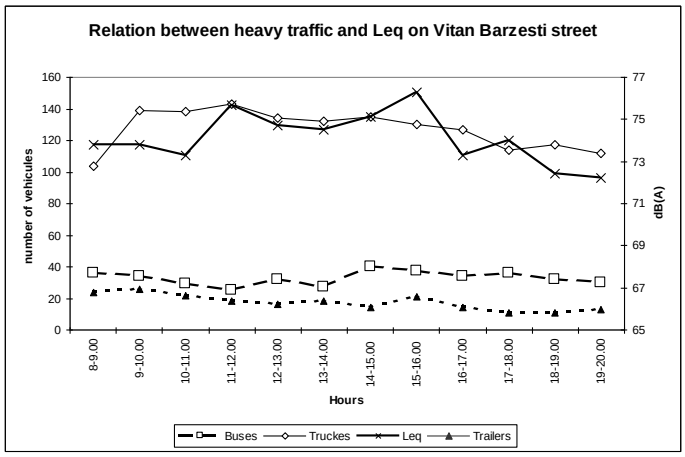

Figure 3. Relation between heavy traffic and Leq on Vitan Bârzeşti street

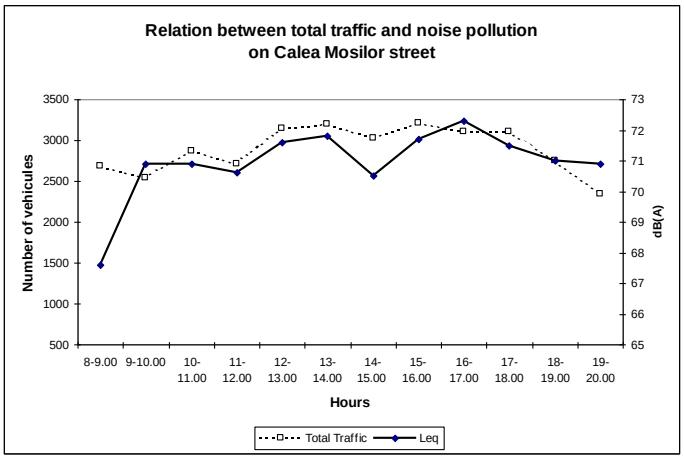

Figure 4. Relation between heavy traffic and Leq on Moşilor street

The technical state of the roads represents an important factor of the Leq dynamics control. On the streets paved with road stone and gravel, the average Leq is 3-4 dB(A) higher than the streets covered by asphalt or concrete, at the same traffic intensity.

The traffic breaking up determined by the traffic lights and other signs (zebra crossings, railway crossings etc) also contributes to the increase of the noise pollution.

For the narrower streets, separated by the surrounding buildings only by sidewalks, high levels of Leq were recorded, due to the lack of protection against the noise impact. Comparatively with wider streets, on this street's category there were recorded values with 3 dB(A) higher, in the same traffic conditions.

The rain is an important factor that contributes to the increase of the noise level by adding the background noise and road humidity. Two short rain periods were recorded during the measurements on Splaiul Unirii and Şoseaua Olteniţei and it was noticed a 2-3 dB(A) increase in comparison with the normal traffic conditions.

The highest Leq levels were recorded nearby the large crossings (Obor, Northern Railway Station etc.) and along the roads with intense traffic (Calea Griviţei, Şoseaua Ştefan cel Mare, Şoseaua Mihai Bravu, Şoseaua Mihai Bravu etc.) or where more noise sources converge (industrial platforms, market places, tram traffic etc.). A significant increase (approx. 5 dB(A)) of the Leq values for the tram line streets or the streets nearby railways could also be noticed.

PRIORITIES IN DECREASING THE ROAD TRAFFIC IMPACT ON THE URBAN ENVIRONMENT

The effects of noise pollution are various and mostly depend on the noise intensity, the frequency and the period of time in manifests. Poor hearing, dizziness, stress, weakening of the attention are the most frequent symptoms of the noise pollution on human beings.

In order to solve the problems related to the noise pollution in Bucharest, the following are proposed:

- measures for reduction of the noise level at source (limiting the noise level produced by vehicles by restricting or forbidding the vehicles with serious technical problems, penalties for the drivers that abusively use the horn inside the city, modernization of the common transportation means etc);
- applying urban measures (rehabilitation of green spaces, finding solutions for traffic deviation - especially heavy traffic - in crowded areas, rehabilitation of the degraded streets lining, introducing speed limits, a better organizing and traffic leading in order to ensure a fluent traffic and to avoid frequent stops, forbidding the very pollutant vehicles etc.). It is appreciated that a forest protection belt of 100 m can diminish the noise level with approx. 20 dB(A) (Hertig, 1996).

- constructions and buildings protection measures (phonic isolation etc.)
- raising population's awareness on the medical problems caused by the noise pollution after long periods of exposure.

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