Environmental noise and influence on the people in urban areas

E. C. RADA*, T. CIRLIORU**, V. PANAITESCU**, M. GRIGORIU***, M. RAGAZZI*
*Civil and Environmental Department, University of Trento
Via Mesiano, 77, 38050, Trento, Italy
**Hydraulics, Hydraulic machines and Environmental Engineering Department, Politehnica University of Bucharest
Splaiul Independentei 313, Bucuresti 060042, Romania
***Director Romanian Cleaner Production Center, University Politehnica of Bucharest
Splaiul Independentei 313, Bucuresti 060042, Romania
Elena.Rada@ing.unitn.it, talida.cirlioru@gmail.com, valeriu.panaitescu@yahoo.com, Mircea.Grigoriu@gmail.com, Marco.Ragazzi@ing.unitn.it

Abstract: Noise is one of the main environmental factors that can influence population together with water, air and waste. Due to technical and economic progress, population is subjected to an increase of the noise level, therefore leading to a series of conditions on the human body. Thus, the involvement of international and national default must know the actual progress in the health of the people affected by noise around them.

Key-words: Noise, noise pollution, health, population, sound insulation, noise barriers.

1 Introduction
Noise is defined as a complex sound with an aperiodic or a low frequency, without taking into account the psychological and social aspects. This involves a qualitative and subjective assessment according to which the noise is "any unwanted or intrusive sound".

Thus, the noise concept can be understood on the following subjective criteria [1]:
- feeling hearing unpleasant or embarrassing;
- process acoustic auditory irritant effects on auditory organ;
- process noise random component non-scheduled without defined.

World Health Organization (WHO) has shown an interest regarding this environmental factor since 1967, when in the "Cahier from Sante Publique, no. 30" it was stated that "the noise exceeded the character of a professional nuisance, becoming a public threat to the physical and mental health. According to the Green Paper “Future policies on noise”, at European level, “environmental noise is considered one of the main problems in Europe”.

Environmental noise is the overall of the unwanted sounds, including harmless ones that can result from human activities, and those caused by transport, road, rail, air and from the sites where industrial activity [2].

The economical and social progress from the urban areas involves a high number of construction sites in inner cities, an increase in road traffic, industrial units, air traffic and hence population growth of cities. All these aspects of modern civilization can have as a consequence the disturbance for the population.

In this article, the impact of environmental noise on health, without reference to the noise that affects people at work, will be presented. It is interesting to note that noise from the urban area is not due only to the operation of machinery, but also because of some human activity.

2 Noise effects on health
One of the major elements for the normal conduct of human activities by day, evening and night is acoustic comfort noise defined by maintaining the recommended parameters. Due to the ongoing momentum of daily activities, noise is one of the most influential factors of stress, which leads to increased fatigue and disturbance in the human activities. For this reason it can be considered as one of the negative "side effects" of civilization. The tendency for the formation of large urban areas results in increasing the number of noise sources, something that is emphasized especially in areas adjacent to traffic arteries and industrial activities.

The main sources of urban noise include road, rail, air and industrial activity in areas within agglomerations. Specific activities of construction, public activities, alarm systems (for buildings and vehicles) and the specific business and leisure consumption (restaurants, shops, workshops, pets, stadiums, outdoor concerts, cultural outdoor events) are other sources of noise specific daily life of human societies. Within the EU, almost 40% of the population is exposed to road traffic noise levels exceeding 55 dB (A), the sound pressure level, weighted on the day and 20% of the population exposed to levels that exceed 65 dB (A). Taking into account all the noise from transport sources, shows that almost half of EU citizens live in areas where not ensure acoustic comfort. For night time, it is estimated that more than 30% of the population exposed to levels exceeding 55 dB (A) and that disrupts sleep.

Technological development, increasing network traffic, airports will increase the noise problems arising from their
specific activities, if nothing is done planning and prevention of this phenomenon.

To stop this trend, legislative measures to reduce noise levels have been adopted by acting "at source", on the noise generating components, and "at the receiver" on the items to be protected from noise (housing, hospitals, schools, rest areas, parks, etc.).

Noise can affect people in different ways, depending on its intensity. It can cause hearing impairment or health in general, productive human activity disturbing, disrupting communication through speaking, leading to disruption relaxing atmosphere that should exist in residential apartments, the disturbance sleep, to create a state of mental agitation.

Adverse effects of noise on hearing occur when exposure is prolonged above the permitted level of auditory perception of the body causing a permanent weakening and generating auditory acuity auditory fatigue, auditory trauma and occupational deafness.

The auditory fatigue is characterized by a transient decrease in auditory perception threshold; it is increasing when the intensity, frequency and time of exposure to noise increase. Thus, a noise with an intensity exceeding 92 dB and a frequency between 500-800 Hz produces after 60 minutes of exposure a temporary decrease in listening.

The sudden sound trauma can be produced by a strong sound that even for a short period of time can cause rupture of the eardrum. Such situations happen in case of explosions, shooting, and rashes intense pressure gas container. After the healing of such lesion the deafness for sound frequencies above 9000 Hz may persist.

Occupational deafness is due to carry out certain activities particularly exposed to noise. Deafness due to noise is characterized by a permanent and irreversible loss of listening [3, 4, 5].

Harmful effects of noise on the whole body are highlighted by the presence of a physiological imbalance. Thus, the general feeling is highlighted as a symptom of great fatigue, weakness, dizziness, syncope, headache, migraine, and anemia. Noise can cause hemovegetative disorders, such as heart rate acceleration, the respiratory rate and blood pressure changes. For example, people who are exposed to intense noise mostly blame a decrease in body weight, despite a nearly normal physiological (eating and sleeping well). Therefore, after cessation of the aggression sound, the subject returns to normal body weight.

Effects of noise as a result of bullying sound are highlighted by the following psychophysiological disturbances [1]:

- minimize the costs of intellectual ability, self-control and behavior;
- difficulty adapting to intellectual work with implications for increasing the degree of fatigue and effort rejection capacity;
- changes in order affective type neural excitation or inhibition in bile;
- status of tachycardia, sleep disturbances, nightmares, sudden awakenings from sleep, anxiety, auditory hallucinations.

3 Material and methods

In the noise field, the European Commission approved the Directive 2002/49/EC of the European Parliament and EU Council concerning the assessment and management of environmental noise, which was transposed in the Romanian legislation by GD no. 321/2005 on the assessment and management of environmental noise (repubhlished).

Noise sources are classified as stationary sources (residential areas, industrial, construction and demolition) and mobile sources (data for urban surface transport network and airports).

At the meeting from Paris (1990), it was established that road transport is the main source of noise in modern society where about 80% of the noise in a city is emitted by motor vehicles. If road noise is caused by the propulsion system, mechanical transmissions and tire contact-way running. The factors that are influencing the level of noise emission factors are: texture tread, propagation factors (distance from noise source) and meteorological factors. Rail traffic noise does not affect the entire population of the cities because is concentrated in certain directions and areas. Gradual change of tram fleet in service, quality track, produce a good effect on surface urban transport this way of transport with a fluent movement, is well perceived by the public as clean, fast and safe [2].

3.1. Noise characteristics

The physical characteristics of noise and sound refer to the intensity, duration and frequency. Noise levels are measured taking into account its intensity and the frequency of sounds that compose it. These features give the noise harmful potentialities, regardless of the preferences and individual mental state. The measurement of noise level is made using sound-level meter, which automatically integrates data captured by the microphone.

In order to point out in a correct and complete manner the characteristics of noise evaluated sound level meter is provided with the possibility of frequency weighting. This is due to the fact that only the middle frequencies are received with maximum responsiveness and the high or low frequencies can be mitigated. This weighting is important when the background noise is relatively low compared with that of the measured source. For different measurements, 4 weighting curves are standardized: A, B, C, and Z. There are only two fundamental weighting filters currently used, A and C, each one corresponding to a frequency weighting curves well defined. The legislation in Romania set the noise limits in the weighting curve A and the measurements results are expressed in weighted dB(A), dBA. If the source emits a constant level of noise, the
sound level meter indicates a constant value over time (the case of permanent sources with continuous emission of noise). The emissions of variable sources have a noise that fluctuates in time. In order to characterize the noise, (whose intensity varies over time and to measure the impact of noise disturbance) at the international level the term of equivalent continuous sound level (LeqA) was introduced. The noise equivalent level is a standardized form of an average noise level on long-term. The equivalent continuous sound level represents an average of sound level over a period of time. When the equivalent continuous sound level is calculated, the period of measurement should be always specified.

The equivalent noise level can be directly registered with an integrating sound level meter, a dosimeter or calculated with a logarithmic formula. One factor that can significantly influence the accuracy of the assessments of potential pollutant noise is the background noise level compared to the one generated by the measured source.

For the high background noise is necessary that the source noise to be at least 3 dB above the background noise in order to prevent the noise generated by the evaluated source.

If the difference Lg - Lf, where Lg is the global/total noise (noise measured with the noise source in operation) and Lf is the background noise level, is less than 3 dB, the background noise is too strong and accurate assessment of source is not possible. If the difference Lg - Lf is between 3 and 10 dB a correction is required. The correction is done with the diagram presented in fig. 1. If the difference Lg - Lf is greater than 10 dB no correction of the results is required.

4 The experimental data
In Bucharest, noise pollution is an important aspect of pollution in general and also a threat to environmental quality of community, along with water and air pollution. Noise pollution in the most important factor is the traffic mess, followed by trade and industrial activities, construction of buildings and public works. This paper presents the data of an experimental activity conducted over two years in order to observe the influence of environmental noise on the urban population.

In this case, monitoring the level of noise in urban areas was achieved using a sound level meter integrating SLM SOLO 01, 01dB mark MetravibhFrance, microphone, sound-level meter is brand MCE 215 - manufacturer GRAS (fig. 2). The device is in accordance with European standards, such as standards: IEC 60651 Class 1, IEC 60804 - Class 1, IEC 1260 - Class 1, ANSI S1.11, and ANSI S1.4.

Fig. 2 Sound level meter SOLO

The locations considered for this study have been: a park, a shopping area, city center, a club.

4.1 Analysis of noise at the boundary of a park
The park where the measurements were made is located in a high traffic area and is bordered by high traffic streets and commercial areas. Noise measurements at the boundary of the park show the level of noise generated by road traffic and commercial activities conducted in the area. Analysis of the sound level meter made to the fleet in high traffic area reveals that noise barrier created by trees and vegetation in the park, is not always efficient to create the desired environment for local residents who come to relax.

Measurements were made between 19:00 h 20:00 (in two different points, see fig. 3 and fig. 4), which corresponds according to the law to the daily period between 06:00 h 22:00. According to the STAS 10009-88 - urban acoustics "maximum permissible noise level areas functional urban – landscape”, the Lech should be 45 dBA.

In order to do the correction, the following steps must be followed:
- the difference Lg - Lf, is attached to the abscissa chart;
- the ordinate ΔL is determined by identifying the intersection with the graph (see direction arrows marked).

The corrected noise level of the source will be: Leq = Lg - ΔL. For the final evaluation of the results the correct values of Leq will be taken into account.
The measurements made during the night (in two different points, see fig. 5 and fig. 6) according to the national legislation have been done between 22:00 and 6:00, and showed the background noise at the boundary of the park. Although at night there is no activity in the park, the road traffic noise exceeds the maximum level allowed by law, that is Lech = 50dB (A) lower with 10 dBA during the day.

4.2 The level of noise generated by activities of a shopping center

Ambient noise affecting people around a shopping center is produced mainly from road traffic in the area and activities related to supply commercial center. Measurements were made during the day when there was an intense activity in the commercial area and customer flow at a high level.

At night, the noise resulting from road traffic and supply activities around the shopping center presented a situation where Lech = 55dB maximum level is exceeded. This is an alarm for the authorities, because the population will be affected over time.

According to the STAS 10009-88 - Urban Acoustics'provides baggage limit premises of noise equivalent (Lech = 65 dBA).

4.3 Noise around a work site in the city center

Because the real estate market has developed very much in the last years, in the urban areas an increasing of the construction field can be noticed. Sometimes these works cause some inconvenience for the neighbors building sites. Thus, any building yard located within the city can have as a result a number of neighborhood complaints because it does not take into account the impact of noise facilities and equipment used at work. In the example shown in the present paper, the construction site is near a street of Class I, very high traffic and near to the apartment where the measurements were made. The apartment is located at a maximum distance of 10 m from the building yard. Measurements were made according to the national legislation and that is: the living room had the doors and windows closed and the data were collected during the day between 6:00 - 22:00 (fig. 9) and during the night between 22:00 - 6:00 (fig. 10).
According to the STAS 6156-86 - Protection against construction acoustic noise in civil and social-cultural - within acceptable limits and acoustic parameters, the maximum allowed in the living room - apartment is \( L_{eq} = 35 \text{dB} \). The noise from the used equipment on a building site has a discontinuous nature and can affect the workers and the people living in urban cities.

4.5. Noise in the vicinity of a club

Urban population is affected not only by the traffic noise of traffic, but also because of restaurants activities, bars and clubs, especially where they have live concerts and the noise isolation is not achieved by a professional team. Thus, there are neighborhood complaints to the competent authorities.

In the present situation, the club is situated on a small street, class IV, and the impact on neighbors across the street is quite significant, especially when inside the club is organized live rock concerts. The example is presented during a concert. We will make the difference between the level of noise inside the apartment situated near the club, and the quite to determine the background noise (fig. 11).

So, if a comparison should be made between the results obtained during the present research, it can be noticed that the highest noise level was registered for the shopping areas (fig. 13). Also other comparison can be noticed in fig. 14, fig. 15 and fig. 16.
5 Conclusions

Urban areas from the Romania and in particular Bucharest, are very noisy. The road traffic, air traffic, trade and industrial activities, construction of buildings and public works, all contribute to high noise level. Thus, the influence on health of urban residents is highlighted getting better, today one can speak of real concern to authorities. Although large cities with over 250,000 inhabitants were forced to make noise maps since 2007, the authorities should use the maps in order to reduce the environmental noise in urban areas for health protection. Street traffic generates a certain intensity noise caused by trucks, buses, hundreds of cars, trains and planes. Today is seeking to prevent the production and transmission noise. Machines or engines to be built are desirable to produce a minimum noise. Buildings to be built should have a sound-absorbing layer anti impact. Ideal would be the introduction of insulating barrier of trees around industrial sources of noise and around residential neighborhoods. Also, home or office, wall insulation and installing double glazing can reduce the sound of traffic, neighbors and other external noise sources.

Panels made along the highways may protect people living close to them by the sound of traffic, but, unfortunately, in our country were we have only two motorways the presence of this types of panels is quite reduced.

Concerning the trend of the research in this field, it can be pointed out an emerging domain related to the exposure index definition for air-noise thematic aggregation. In general, aggregation indices or indicators of different themes is a hard exercise because condensing information of different kind can lead to misinterpretations if not correctly explained. The aim of this emerging field is not to provide future users with a metric that would quantitatively measure the effect of transport policies on health or quality of life. Indeed, aggregate exposure indexes can provide a picture of the status of the environment highlighting areas or populations under conditions of multi-exposure. This methodology is still open to an international discussion as explained in the recent literature [7]: the expected results will be very useful for the decision makers.

References: