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► To cite this version:

Narjes Khatoon Fazeli. The effects of Metropolises noise pollution on human health and effective strategies to control and reduce it. Second National Conference on Modern Research in Agricultural, Environmental and Natural Resources Engineering, Jun 2018, Karaj, Iran. hal-02314268

HAL Id: hal-02314268

<https://hal.science/hal-02314268v1>

Submitted on 21 Oct 2019

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The effects of Metropolises noise pollution on human health and effective strategies to control and reduce it

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Abstract

Along with the advent of industry and the increasing population in cities and the spread of the use of motor vehicles, today noise pollution has been recognized as a threat to human health. Noise pollution is one of the major environmental problems of cities that, however, has been increasing in terms of intensity in recent years. Exposure to noise threatens human physical, mental and mental health. Noise pollution has a variety of sources, including motor vehicles in urban traffic and industrial plants operating in the city. Therefore, a number of laws are necessary to control and reduce noise pollution. The article deals with the sources of noise, standards related to noise levels, the effects of noise on human health and suggested ways to reduce and control the type of pollution.

Keywords: Noise pollution, Traffic noise, People's health, Hearing loss.

1. Introduction

Population growth, coupled with industrial development and metropolitan technology, creates many problems for people, with environmental pollution being one of the most important problems. Noise pollution - as one of the most important environmental pollutants - contributes significantly to such problems [1,2]. Noise, however, is an integral part of modern and quasi-modern life. In recent years, science and technology together have made remarkable progress in all areas of industry, so that one of the major dangers of industrialization is noise pollution [3-5]. In acoustic science, noise is defined as audible acoustic energy, which has a positive and negative effect on the physical and mental health of living creatures [6,7]. Sound is caused by the vibration of air molecules and constant pressure changes. Therefore, acoustic waves are types of mechanical waves that propagate in the form of longitudinal waves and allow the ear to hear [1]. In most developed and developing countries, particular attention has been paid to the issue of noise pollution, as effective measures have been taken to formulate and enforce the laws to reduce or eliminate noise pollution [1-8].

2. Sources of noise pollution

Nowadays, with noise pollution being considered as one of the environmental pollution and its negative effects on human life, experts have investigated some of the factors causing noise pollution, such as car and noise pollution due to urban traffic which is the main cause of noise and air pollution [1,9,10].

The noise levels caused by road vehicles, however, have a major share in the noise generation of cities. Examples of noise pollution that threaten the health and well-being of living creatures, especially humans, are: Population growth, motor vehicle overload, road traffic, aircraft noise, presence of some industrial plants within city, urban and interurban trains and etc. [1,11].

2.1. Sound sources are divided into natural and abnormal categories:

2.1.1. Normal sources of sound

During the earthquake and its short period of time, the closer the source of the earthquake, the closer the source of the noise is due to the release of energy from the rapid failure of the crustal faults. Lightning is a severe and very rapid electrical discharge in the air that produces electricity and high noise; the sound is caused by the split layers of air.

2.1.2. Abnormal source of sound

2.1.2.1. Fixed sources of sound

Because of the equipment like gas turbine, compressor, combustion chamber, strong fans, etc., gas power plant produce a lot of noise which is annoying to the people around them.

2.1.2.2. Non-fixed sources of sound

Until a few years ago, car makers and designers focused on reducing car fuel consumption; while today the focus has been shifted towards reducing the noise emitted by cars. Using either public vehicles (city trains) or personal vehicles (cars and motorcycles) produce noise pollution. However, the noise caused by cars is due to a variety of reasons, such as the use of horns, automotive aerodynamics, car engine design, tires, car mirrors; and the noise of urban trains is due to intersections in the direction of movement, electric motors, rotation on rails and stops [4].

2.1.2.3. Internal sources of Sound

All available electrical equipment, due to its electric motor and its performance, generates sound. In internal combustion engines or in combustion engines, the fuel mixture and the oxidizer are reacted inside the enclosure chamber; this process being accompanied by the generation of noise.

3. Acoustic Pollution Standards

In the last two decades, in most countries, special attention has been paid to the issue of noise pollution, which in turn has led to issuing some regulations and laws to deal with noise pollution [1,12]. In Iran, measures have been initiated to deal with environmental pollutants. In this regard, two types of standards have been established for determine sound effects in Iran:

- 1) Emission Standards: Applying the standards, one can calculate the output levels of sound sources [1,13].
- 2) Environmental standards: The standard sets the threshold limit for different urban environments [1,13].

Table 3 shows the environmental standards of Iran, which are announced by Iranian Department of Environment. According to the table, urban areas of Iran are divided into five categories [1].

Table 1: Standard Pressure Limit Level of Air Pressure in Iranian Open Air [1,4,13].

Type of area	7 o'clock to 22 o'clock	22 o'clock to 7 o'clock
Residential	55	45
Residential- Commercial	60	50
Commercial	65	55
Industrial - Residential	70	60
Industrial	75	65

4. The effects of noise pollution

Noise, just like all pollutants, reduces the quality of life and creates significant health risks. The steady increase in the volume of highway traffic in urban areas has increased the number of problems affecting life. The high number of cars, their speed as well as the use of nonstandard horns causes problems in the areas around the highways [14,15]. Researches indicate that destructive noise can have an adverse effect on different organs of the human body and organ [4,5,14,16,17]. Approximately, 120 million people in the European Union are exposed to traffic noise of about 55 db. and over 50000 people are exposed to traffic noise of about 45 db.

The most common side effects of noise are human hearing loss. Even non-annoying but persistent sound is harmful to humans and reduces the sensitivity of the ear to the variety of sounds. Hearing a 100 dB sound for 10 minutes requires a 20-minute rest in a quiet environment to compensate for the effect. Also, working in noisy environments destroys hearing cells and results in "irreversible hearing" which is so called as "job deafness". Continued exposure to noise, along with other factors such as aging, background of some diseases, can accelerate hearing loss [18,19].

Although noise-induced hearing loss is preventable, however, it is currently one of the major general health problems and consider as one of the major diseases caused by prolonged exposure to noise and irreversible [20-28].

Approximately, 1 to 4% of the population of developed countries is exposed to dangerous levels of noise, which means that the hearing protection program is somewhat ineffective in these countries [29]. Examples of the reverse effects include: nervous tenderness, severe irritability, muscle cramps, dizziness, physical and emotional exhaustion, sleep disturbances, impaired vision, increased heart rate and blood pressure, convulsions, aggression, and ultimately general body weakness [4,5,20,31,32,33,34,35]. Sound pollution even affects insulin secretion [14,36]. In the study of social injuries, complications such as fatigue, aggression, irritability, and family problems are common [37, 38]. Many environmental experts believe that in the past few years, noise pollution has come under the influence of other pollutants.

5. Noise pollution control

To prevent the psychological and social effects of noise, the World Health Organization (WHO) has stated that the noise level should not exceed 55 dB at days and not 40 dB at nights [14,39,40]. Several methods have been proposed to reduce the emission of noise pollution caused by car traffic, as following:

- 1) **Creating Distance:** creating distance between highways and the surrounding residential areas; in fact, residential areas can be built at a distance from the highways [4].

- 2) Use of semi-soundproof walls: These walls, known as acoustic barriers, are located between highways and residential houses [14,41]. Proper and practical barriers can reduce traffic noise by 10 to 15 db. The obstacles can be hill of suitable height, barrier walls made of wood, stone, plaster, concrete or other suitable materials.
- 3) Suitable vegetation: Building and expanding green space is one of the best ways to reduce traffic noise. In addition to reducing the level of noise pollution, green space has good psychological and psychological effects on people [8]. If these types of coatings are suitable in terms of length, width, thickness and density, they can reduce noise by up to 10 dB, while this type of insulation is economically and sustainably recommendable.
- 4) Insulation: Using double glazed windows in houses is one of the most effective solutions.
- 5) Prohibition of worn-out vehicles: A ban on the use of worn-out cars can have a positive effect on noise reduction.
- 6) Prohibition and penalties for vehicles using non-standard horns: another possible way is to ban on vehicles which using non-standard horns and make traffic noise.
- 7) Identifying and fixing the noise factors in the car:
 - Engine: The most important source of noise in the car is noise due to combustion, injector and cooling fan.
 - Vehicle Components: Changes to materials used in the manufacture of automotive body parts, or the use of high-density steel or plastic sheets, and the placement of steel fasteners to reduce and dampen the vibration energy of valve caps.
 - Gear Noise: If each gear is fully fixed and adjusted, with good lubrication and improved gear-shell, it has a good effect on noise reduction.
- 8) Training and promotion of traffic culture [14].
- 9) Electric vehicles are considered as one of the best options for replacing ordinary vehicles (internal combustion engine). One of its reasons is its environmentally friendly properties. One of the most important features of electric vehicles is its environmentally- friendly features which is the replacement of the electric motor rather than the internal combustion engine, so it can be a good mean to reduce noise pollution in cities [42].

It should be noted that due to the altitude, air temperature and humidity available, the acoustic energy emitted by the vehicle's motion is absorbed by the atmosphere (table 2) [6,43,44,45].

Table 2: Meteorological data used in sound/noise simulation [6].

Season	temperature	Relative humidity percentage	Prevailing wind direction	prevailing wind speed (Miles per hour)
Winter	43.6	56.5	135	5.7

Smooth and hard surfaces - such as road surfaces- absorb little noise, while soft, porous surfaces - such as meadows and grass- weaken sound levels. Also, proper vegetation can absorb sound/noise waves [6,46]. The intensity and frequency of acoustic perturbations depend on the characteristics of the sound or noise

source. For example, the noise caused by moving vehicles on roads depends on the number, type, and speed of movement, vehicle body design, wind speed and direction [6].

Accordingly, noise maps have been developed in many large and small cities around the world and extensive studies have been conducted to reduce noise [4,49, 50]. Take, for example, London's Noise map (Europe's largest metropolitan area) or some parts of Madrid (Europe's third largest metropolitan area).

Noise measurement is a prelude to identifying priorities in identifying areas and areas of influence and judging the outcome and practices of traffic control; in fact, these researches have been conducted to determine the exact location of hospitals, medical centers or similar centers. In this context, several international valid standards have been defined in which the methods of measuring noise and permissible noise levels are discussed [47,48].

Traffic noise level depends on several factors that can be divided into three categories:

- 1) Traffic volume (Traffic noise of 2000 cars per hour is twice that of 200 cars per hour) (table 1);
- 2) Traffic speed (Traffic noise at 65 mph is about twice that of 28 mph at 55 mph).
- 3) Type of vehicles in traffic (The noise from a truck at 55 mph equals the noise of 28 riders at 55 mph)

Table 3 presents the daily and annual traffic volumes of vehicle types in a given route.

Table 3: Annual and daily traffic volumes of vehicles [6]

The parameters	sedan	Van	Bus	truck
Annual number of each type	96212	14994	25590	36111
Daily Percentage	38.5	6	10.2	14.5
Two-thirds of traffic a day	25.8	4	6.9	9.7
Ten hours daily activity	64.5	10	17.1	24.2
The number of cars per minute at an average speed of 80 km / h	21.5	3.3	5.7	8.1
Distance of cars on each track	1256.6	8062.9	4724.4	3347.9
Number of cars per route	11	2	3	4
Average sound intensity	73.7	77.9	76	78.1

6. Conclusion

Noise pollution has grown dramatically in recent years due to both natural and social phenomena. Population growth coupled with industrial development and metropolitan technology poses many problems for urban dwellers, with noise pollution being one of the most important problems.

There is a positive relationship between industrial technology and noise pollution; in other words, as technology evolves, the problem of sound also becomes wider and causes more problems. The problem of this type of pollution, however, is considered as one of the most important environmental issues in most industrial areas and has even been considered in macro management of urban planning, interior architecture, residential and commercial. Researches show that the distractions of today's life create

physical, mental, and psychological distress for metropolitan citizens. Therefore, it is necessary to regulate the control of this type of pollution and to establish appropriate laws to prevent, reduce and control it.

Present paper deals with the sources of noise, standards related to noise levels, noise effects and suggested strategies to reduce and control this type of pollution have been granted. Using electric vehicles as well as expansion of vegetation in noisy environments are among two examples of noise pollution control strategies.

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