Survey of Noise Pollution in Zanjan, and Comparing them with Standards

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Abstract— In the last century, the health of human beings has been affected by the industrial developments. Among some problems which jeopardize human health, we must point to environmental pollution by making noise produced by artificial machineries like cars, buses, motorcycles, airplanes, etc. Thus, we decided to study noise pollution in Zanjan. Here, we investigated the noise pollution of Zanjan Province to provide the rates of Noise levels through the city during hours of different days. After collecting and analyzing data, we compared the final results of commercial, residential, and commercial residential regions with prepared standards. The noise pollution rate of all regions was compared with the standards defined for the country. The most effective factors on noise pollution were identified and its control methods were introduced. Finally, the noise pollution map of different regions are extracted that can help to identify the best locations for health cares, marketing, etc.

Index Terms— Sound, Noise Pollution, Sound Intensity Level, Mean of Sound Intensity Level

1 Introduction

In past decades, apart from the air pollution, the contribution of noise pollution in human life has been taken a considerable attention. The center of professional sanitation, in one of the Scotland universities, studied on social influences of hearing reduced by machineries' noises between 1969 and 1970. Groups who deal with large machines have lower hearing threshold than the others, and this center discovered other mental and psychological damages which are caused by noise. Some researches, which were done Rosler (1985), Ward and Melnick (1991), and Saunders (1994), respectively, show that sense of hearing decreases, and internal ear is damaged when people deal with very high frequency sounds (4000 Hz).

After forming professional sanitation in faculty of sanitation in Iran in 1972, for the first time, noises produced in weaving environments were investigated. Results clarified that workers' hearing was badly damaged after several years. Another research, which was done in 1977, studied on 844 workers' hearing by audiometer. The results of hearing evaluation and noise intensity showed that to decrease of the ability of hearing for the workers has direct relationship with the noise in work. Also, daily work break has reverse effect and helps to their hearing healthy. In a research done in Iran during the years 1982 to 1983, both the permanent and temporary loss of hearing in of textile factory was studied for 157 workers. All obtained results confirmed that the intensity has direct effect on decreasing of hearing ability. Other important researches done in 1981, 1982 and 1983 confirm the previous results which all were made in job environment [1].

Noise pollution can be seen in some schools with no appropriate acoustic walls. This problem is observable in office of employers, doctors, and also, sometimes libraries. In 1991, some studies explained that the noise level of high speed trains is higher than the standard levels. The most significant problem was related to the hearing and speaking during commuting trains.

In house environment, the highest level of annoyance is related to the sound of TV. Among the members of family, mothers suffer more than children and find *more* psychological *problem*s. In order to investigate the effects of traffic on the process and quality of the sleeping, Rylahder and Ohrstorm have conducted one study on 28 participants at age groups of 20 to 29. Some other studies are about the level noise made in house by TV that has direct relation with quality of sleeping. Results demonstrate that when the intensity level of sound takes values greater than 60db, the quality of sleeping is more affected.

In nowadays life, to provide welfare services, such as health care about noise pollution, we need to have a better understanding about noise, and prepare a map containing noise values within different parts of areas. The distractive effects of noise pollution based on chemical security international program (1994) has proved that the distractive effect of noise pollution is a type of morphological and physiological change that it will finally lead to the increase of sensitivity to the distractive effects of environmental factors. This definition includes any type of temporary or long-term physical effects that can have influence on physiological or social relationship of the human being.

The distractive effects of noise pollution include: Hearing loss; the intervention with oral communications; its effects on vision limbs and the decrease of reaction to the light; balance

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perturbations; disturbance in resting and sleeping; its effect on electrolytes such as sodium (its negative role on its adaptation with heat); physiological damage such as nerve stimulation, variations in heartbeat, blood pressure, the consumption of oxygen and the rate and the number of breathes.
The side effects cause to decreasing in the operational efficiency and increasing risks. Different people can be impressed differently based on their ages and situations.
In this research, we collected data related to the intensity level of noise in different parts of Zanjan, and then, the extracted results were compared with country standards. It has been tried to collect all data in the same conditions. More details about passible errors and the procedure of gathering data are discussed in section Results and Discussion.

2 DEFENITIONS AND EQUATIONS

Sonic waves are a kind of mechanical waves (carrying energy) propagated in elastic solids, liquids, and gasses. Sound intensity level (β), is logarithm of proportion of acoustic intensity (I) to reference intensity of sound (I_0), stated in terms of Bell (B) or deci-Bell (dB). This is formulated as follows:

$$\beta = K \log_{10}(I/I_0) \quad (1)$$

where K has a constant value. For K=1and K=10, β is stated in terms of (B) and (dB), respectively.
According to the Doppler equation, when source of sound and detector (observer) are closing, acoustic intensity are increasing and vice versa. So frequency, which is received by detector, is related with velocity of both source and detector. Doppler equation is in general:

$$\vartheta(o) = \left(\frac{v - v(o)}{v - v(s)}\right).\vartheta(s) \quad (2)$$

Where v, ϑ, s and o are representative of velocity, frequency, source and observer, respectively [2].
For calculating mean of sound intensity level, because of its logarithmic nature, the formula is as follows

$$\overline{LP}(dB) = 10\, log_{10}[\sum_{i=1}^{n} 10^{LP(i)/10}] \quad (3)$$

where $\overline{LP}$ is the mean of sound intensity level. The parameters LP(i) and n are sound intensity level at each locations and number of places used in experiment, respectively [3].
According to execution of regulations for preventing noise approved by council of ministers in 1999, sound is longitudinal waves generated by vibrating bodies and matter concluding solid, liquid and gas. Sometimes instead of expression 'sonic waves', we can use 'airborne waves'. Three main characteristic of sound waves are frequency, wavelength and velocity of propagation. Human ear hears sounds that its frequency is between 16 Hz and 20000Hz. According to this regulation, noise is propagation, scattering of sound and relevant vibration which is higher than appointed standards in outdoor. [3]

3 METHODS

3.1 Summary of standard measurement of sound, a description about the device and method

First of all, we choose some important places across the city for measuring sound intensity level. For measurement, weather conditions should be relaxed. Then, we put device on the tripod (with 1.5-meter height). For reducing fault caused by walls and barriers which are behind device, we placed that at 3.5-meter distance from behind barriers. In open environments, because of variable and continuous sound, we should use mean of intensity level (L_{eq}) instead of instantaneously intensity level.
Our device (Sound Level Meter-SLM) has three main parts which are: 1. Microphone, 2. Digital Display. 3. Processor. It can calculate mean of sound intensity level (L_{eq}), instantaneously, intensity level, maximum and minimum dBs, intensity peaks, simultaneously. The other necessary point is device calibration. We have to calibrate device in each day.
We started to collect data on 2 July 2011, and after 10 days, 12 July 2011, collecting data ended. We were collecting data related to sound intensity levels of 17 different places in 15 consequent hours, from 7 A.M. up to 22 P.M., in Zanjan. We chose 10 minutes per hour, which was totally stochastic, in any places for collecting and classifying data.
After classifying data, we started to work on data. For analyzing, we employed some special software, MATLAB and Excel, for numerical calculation and drawing diagrams. By using them, we obtained means and afterward we drew diagrams representing data versus hours. And then we interpreted results derived from analysis.

3.2 Errors

Having interpreted results, we explained errors that probably occurred during collecting data. In this study, Errors is divided two groups: 2.1 Natural errors: a. Background sound, b. Absorption by weather, c. Gradient of wind velocity, d. Temperature gradient. 2.2 Artificial errors: Sometimes measurements are perturbed by echo because there isn't enough distance between rear wall and our device. Sometimes some people made noises by hooting, whistling, etc. [3].

Table 1. The standard of sound intensity levels (dB) defined for different regions over the day and night [10].

Night	Day	Type of Region
45	55	residential regions
55	65	commercial regions
50	60	residential-commercial regions

4 RESULTS AND DISCUSSION

After recording noise level from various places over Zanjan as explained above, we represent a small sample of our data set below. Figures 1, 2 and 3 belongs to the noise intensity levels taken in different hours in residential (denoted by *), residential-commercial (denoted by **), and commercial (denoted by ***) areas. It is seen that the noise intensity levels are greater than national standards defined by Table 1.

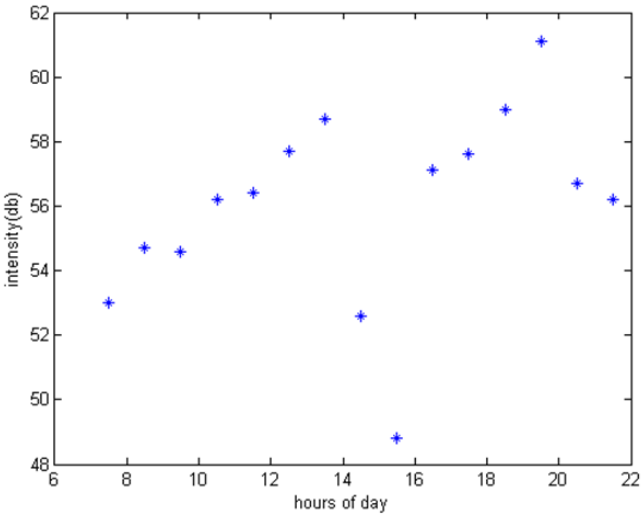

Figure 1. (*) The intensity noise level of one of streets in township. The most intensity levels have values lower than 58 dB. Around 13 to 16 dBs, it is seen that there is a decreasing in intensities.

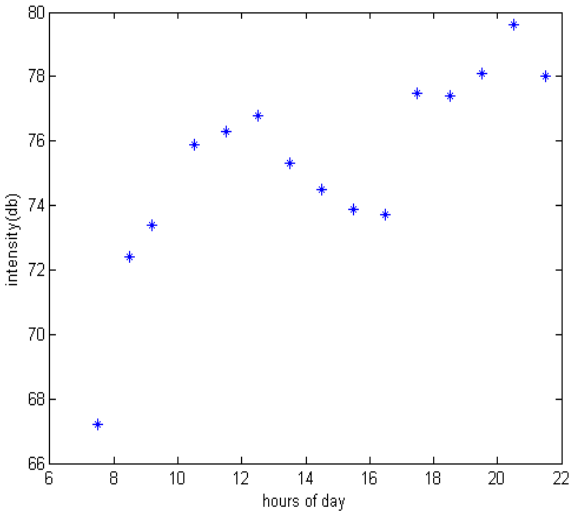

Figure 3. (***) The noise intensity of Amir Kabir intersection. This place is one of the busiest and nosiest locations in Zanjan. As it is seen, the most of the data are higher than 72 dB. It is seen that there is a minimum value around 8. After 17 pm, there is an increase in the noise intensity level.

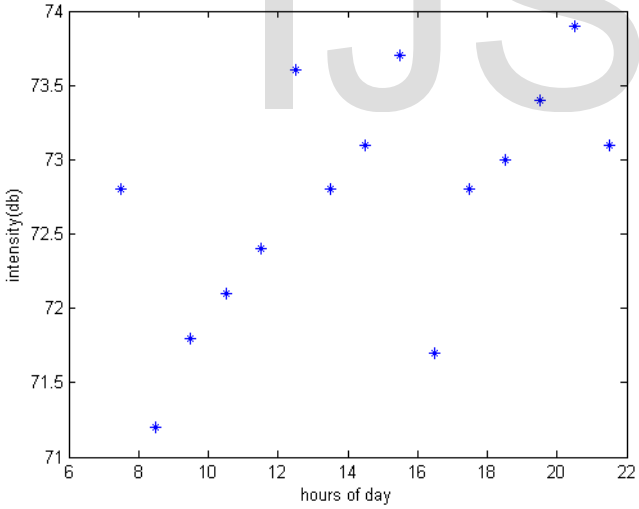

Figure 2. (**) The intensity noise level of one of the residential-commercial areas in the city (Kuche Meshki). Most of the data are higher than 70 dB. It is seen that the level of noise intensity takes higher values around 12 and 19, and the lowest level of noise intensity is around 8.

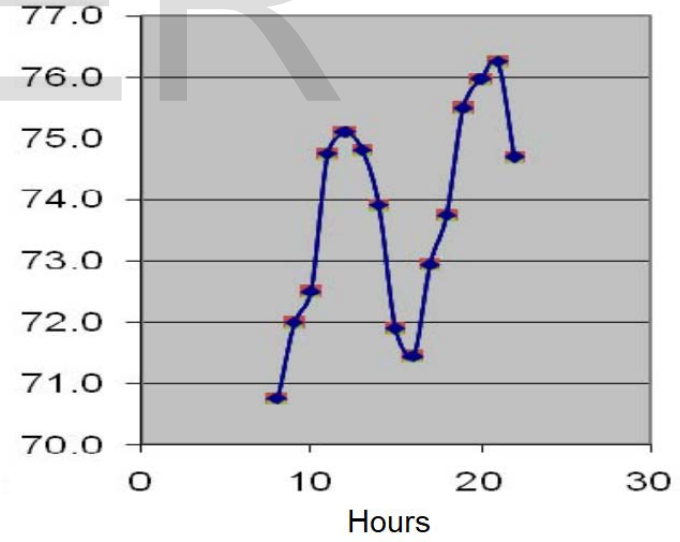

Figure 4. The average intensity noise level obtained from different areas in the city. It can be seen that the average noise intensity of these 17 areas has two peaks over 24 hours.

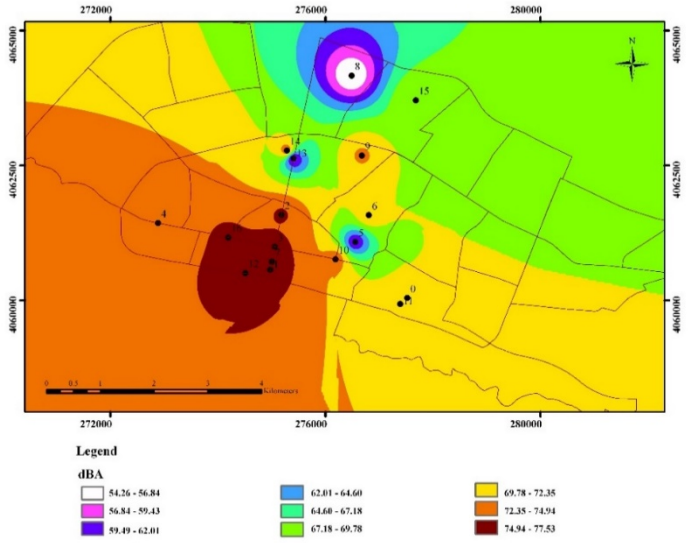

Figure 5. Soundtrack Plotting Map in Zanjan.

Using Figure 4 and our national standards approved for sound intensity levels (Table 1), we compared the average of data points with standards in 3 different types of locations (residential areas, commercial areas, residential-commercial areas). According to Figures 1, 2, 3, and 4, it seems that there are two peaks over 24 hours. These maximum values for noise intensity level are in the range of 11 to 13, and also, 19 to 21. It is found that that sound intensity levels in each type of areas are higher than standards except of some residential areas and during just in special hours. Almost each diagram represented two picks in a day, which were representative of rush hours. In common, rush hours are both in the range of 10 am to14 pm, and also, in the range of 19 pm to 21 pm. According to Figure 5, it is seen that the most areas selected for our analysis has greater values than values given in national standards. The map shows that lots of areas takes values more than 67 dB for noise intensity level. Map of city for separating types of locations on the basis of noise pollution, constructing buildings on the basis of noise pollution, modifying standards, de-termination of pollution procedure, and adapting sonic generator's apparatus in controlling sounds and noise.

4 Conclusion

In this study, the data related to the intensity level of noise is gathered from different parts of Zanjan. The extracted results were compared with country standards. In conclusion, in our research commercial areas had very high sound intensity levels. So, people who live in commercial areas are in the expose of mental pressures more than the others. Rush hours are really related to the velocity of vehicle which is related to Doppler effect. Therefore, in calculating sound intensity levels, number of moving objects isn't very important factor. Dominant factor is source velocity. This research has a lot of applications in so many fields like determination of fining system for environmental pollution, popular complaints, making sonic map of city for separating types of locations on the basis of noise pollution, constructing buildings on the basis of noise pollution, modifying standards, determination of pollution procedure, and adapting sonic generator's apparatus in controlling sounds and noise.

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