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► **To cite this version:**

Mohammad Ehrampoush, Gholam Hossein Halvani, Abolfazl Barkhordari, Mohsen Zare. Noise pollution in urban environments: a study in Yazd city, Iran. Polish Journal of Environmental studies, 2012, 21 (4), pp.1095 - 100. hal-03389577

HAL Id: hal-03389577

<https://univ-angers.hal.science/hal-03389577>

Submitted on 21 Oct 2021

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Short Communication

Noise Pollution in Urban Environments: a Study in Yazd City, Iran

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Received: 26 July 2010

Accepted: 7 April 2011

Abstract

One of the most important sources of noise pollution in urban areas is traffic noise. The aim of the present study was to determine noise pollution in the different parts of Yazd city in 2010 and to compare them with current standard levels.

In total, 135 samples were obtained from both residential and commercial areas according to the ISO 1996-2002 method in order to measure noise pressure levels. Locations included 10 streets and 5 squares of the city and the measurement times were considered in the morning, afternoon, and the evening. Noise level was determined in A-weighted by sound level meter model 2232.

Results showed that the rate of background noise in Yazd city was high, as it was 71.2 ± 4.4 , 66.2 ± 3.7 , and 60.3 ± 4 in the L_{10} , L_{50} , and L_{90} , respectively. The mean level of maximum noise pressure was 74.3 dB(A) (L_{max}), and the mean continuous sound equivalent level was 66.7 dB(A) (L_{eq}).

Comparing the noise level obtained in the present study to the standard level, it can be obviously concluded that the noise levels are higher than that of acceptable levels in most parts of the city. So, different preventive countermeasures such as increasing public awareness through educational programs and technical controls for the future development of the city are crucial.

Keywords: noise pollution, equivalent sound levels, Yazd city, noise levels, traffic

Introduction

In the last three decades, environmental pollution has gained worldwide attention and noise pollution in cities has been a worldwide problem [1]. According to WHO guidelines 40% of the population that lives in European countries are exposed to equivalent sound pressure levels of more than 55 dB(A) daytime, and also about 20% of this population is exposed to levels above 65 dB(A): WHO empha-

sized that noise pollution is a acute problem in developing countries [2]. Noise pollution is growing and this growth has caused some complications like health effects, impact on future generations, socio-cultural effects, and esthetic and economic outcomes.

Evaluation of noise pollution in major cities is so important that Steenberg in his study in Denmark has pointed to this problem and evaluated governmental strategies for tackling noise pollution in big cities in the last two decades. The study has pointed to the fact that vehicular and city traffic is the major noise pollutant in cities [3].

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A German study studied the effect of vehicular and traffic noise pollution on increased incidence of ischemic heart diseases [4]. A study in Sweden showed the significant relationship between traffic noise and sleep parameters, including quality of sleep, and waking up and closing of windows at night. Similarly, it also affects the quality of sleep and day drowsiness in children [5].

In another study in the city of Varanasi in India, results showed that noise levels have reached alarming levels and 85% of people are troubled by traffic noise. Approximately, 90% of the population under study considered noise as the major factor responsible for headaches, hypertension, giddiness, and lethargy. Also, people with higher educational and income levels were more aware of the detrimental effects of noise pollution on health [6].

The results of a study in Dublin, Ireland, showed that the rate of exposure to noise was more at night and traffic management can help reduce exposure of residents to noise pollution [7].

Taking into consideration the above-mentioned points, Yazd city with a population of 350,000 is one of the cities at risk of high levels of noise pollution due to increases in motor vehicles, inadequate roads and streets, and improper distribution of commercial, residential, and industrial areas. Similarly, an increase in the number of motor vehicles and inadequate widening of the streets, especially in the city center, has led to traffic congestion in the city during certain hours of the day. Use of improper horns for motor vehicles along with other factors ultimately leads to noise pollution in the city. In order to control noise pollution as a major step toward controlling the effects of noise pollution among residents, initial measurement of the rate of noise pressure levels and parameters including day average sound levels (DL), statistical levels ($L_n = L_{10}, L_{50}, \dots$), noise pollution levels (NPL), and equivalent sound level (Leq), as well as evaluation of its level with the current Iranian standard level is of crucial importance. Therefore, considering these points, we decided to determine noise pollution in different parts of Yazd city and to compare them with the standard levels.

Materials and Methods

This study was an exposure assessment study performed in Yazd city in Iran. After checking and reviewing the city map, 10 streets, including Qiyam, Farokhi, Safaeiyeh, Taleghani, Daneshjou, Jomhuri, Sadoughi, Dahe Fajr, and Sayed Golesorkh, and 5 squares, including Shahid Beheshti, Amir Chaghmagh, Bagh-e-Melli, Bahonar, and Imam Hussein squares (all commercial-residential areas), were selected for this study. A total of 135 samples were obtained from the selected areas in the morning, afternoon, and evening. Three sampling times selected in this study were based on the previous study [8].

Noise level was measured using sound-level meters, which record the changes in noise level on the basis of sound pressure. The principal noise index was the LAeq,

the A-weighted equivalent continuous level averaged over a specified time period, which was determined directly from the sound level meter. The descriptors had an average time of about 30 minutes during morning, afternoon, and evening times. Moreover, we used shorter or longer sampling intervals in certain cases. All the samplings were completed over different days and at different times to ensure that the survey is statistically representative of the existing conditions of the noise pollution. These times were 7:30-9:30 a.m., 12:30-2:30 p.m. and 7:00 p.m.-9:00 p.m., when the traffic was in rush hours status. Noise measurements are taken in a distance of at least 3.5 m from buildings. The microphone was set at the height of 1.5 m from the ground. Measurements were performed when weather was sunny, wind was less than 3 m/s, and temperature was about 25°. The typical environmental noise measurement parameters in this study were as follows:

- LAeqT: The average noise level during the measurement period (T), which includes all noise events.
- LA90: The noise level exceeded for 90% of the time, general representative of the steady background noise at a location.
- LA50: The noise level exceeded for 50% of the time.
- LA10: The noise level exceeded for 10% of the time, it is a measure of higher noise levels present in the ambient noise.
- LMax: is the instantaneous maximum sound level measured during the sample period.

Traffic noise Index (TNI): The TNI is a method used for the estimating annoyance responses due to traffic noise and is computed using the following formula [9]:

$$\text{TNI} = 4 \times (10\% \text{ level} - 90\% \text{ level}) + 90\% \text{ level} - 30 \text{ (dB)}$$

Noise Pollution Level (NPL): calculated by the following formula for each area code of the city [10].

$$\text{LNP} = \text{LAeq} + 2.56\sigma$$

All of the measurements were done according to The International Standard for Assessment of Environmental Noise ISO 1996 "Acoustics – Description and Measurement of Environmental Noise" [11]. The commercial-residential areas over which measurements were done are shown in Fig. 1. The area codes of studied areas are also indicated on the city map.

Table 1 shows the Iranian standards of sound levels in the environment. It is according to maximum A-weighted equivalent sound levels (Leq) in 30-minute time intervals. Our measurement was implemented on a daily base, and for this reason the daytime standard was adopted in the current study.

In this study, we checked traffic volume for each of the sampling locations during sound level measurements. Vehicles were monitored in 5-second periods. Vehicle types that were encountered in various sites included motorcycles, pickup trucks, van and motor cars.

Table 1. Acceptable sound levels in open air conditions of Iran.

Type of Area	Day (7a.m -10p.m) Leq (30 min) dB (A)	Night (10p.m-7a.m) Leq (30 min) dB (A)
Residential	55	45
Commercial-residential	60	50
Commercial	65	55
Residential-industrial	70	60
Industrial	75	65

Results

The mean of traffic volume within each measurement time monitored in vehicles per 5 second (veh /5sec) is reported in Fig. 2. As shown, the mean of traffic volume in the 10 locations is plotted in morning, afternoon, and evening. The correlation between Leq and traffic volume was observed.

The daily measured sound level is displayed in Fig 3. It shows the values for all of the study sites. The A-weighted sound level Leq in site 1 was 71.7 dB(A) during 7:30 a.m.-9:30 a.m., and it was measured 73.6 dB(A) in site 2, 12:30-2:30 p.m. This level was 75.1 dB(A) for the period 7-9 p.m. in site 3. The mean value of Leq in various locations during 7:30-9:30 a.m. was 75.2 dB(A), which is higher than the maximum permissible limit.

Also, the overall mean value of Leq was 74.52 and 77.3 during 12:30-2:30 p.m. and 7-9 p.m., respectively. All of these measurements exceeded the governmental regulations in Iran (Fig. 4).

Maximum Equivalent Noise Level (L_{max}) in the morning at Bahonar square was 77.5dB(A) and 79.8dB(A) at Bagh-e-Melli square in the afternoon. This level was 80.7dB(A) on Farokhi Street in the evening (Fig. 3). The highest L_{max} levels during all three time periods were on Farokhi Street. According to Fig. 3, continuous equivalent sound levels in most sites exceeded the recommended standard levels of the regulations set by Iranian government during all the periods: either morning, afternoon or in the evening. The maximum TNI was 93.5dB(A) in area codes 5 and 8 in morning, and it was 98.3dB(A) in area code 13



Fig. 1. Distribution of the areas where sound was measured in Yazd city, 2010.

in the afternoon and in area code 12 it was measured 105.9 dB(A) in the evening.

The maximum amount of NPL in area codes 5 and 8 was 84.3dB(A) in the morning, and in the afternoon in code 13 it was 87.7 dB(A) and in the evening, in area code 13, the noise level was 90.1 dB(A) (Fig. 5). Similarly, the maximum traffic noise index (TNI) was the highest during all time periods on Taleghani Street.

In Fig. 6, the mean traffic noise indices (TNI) and the noise pollution levels (NPL) have been compared in all of the fifteen area codes of Yazd city during morning, afternoon and evening.

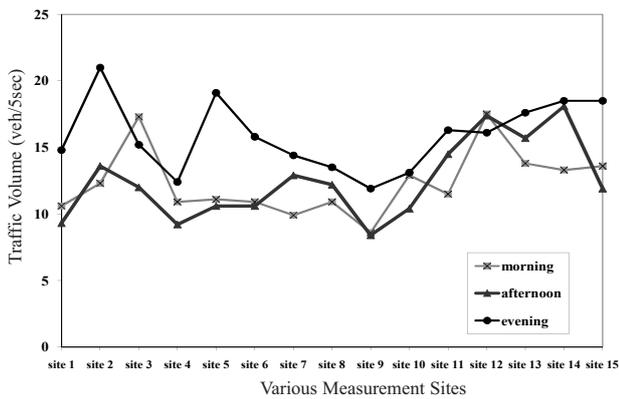


Fig. 2. Traffic volumes per 5 seconds in relation to various sampling sites 1 to 15.

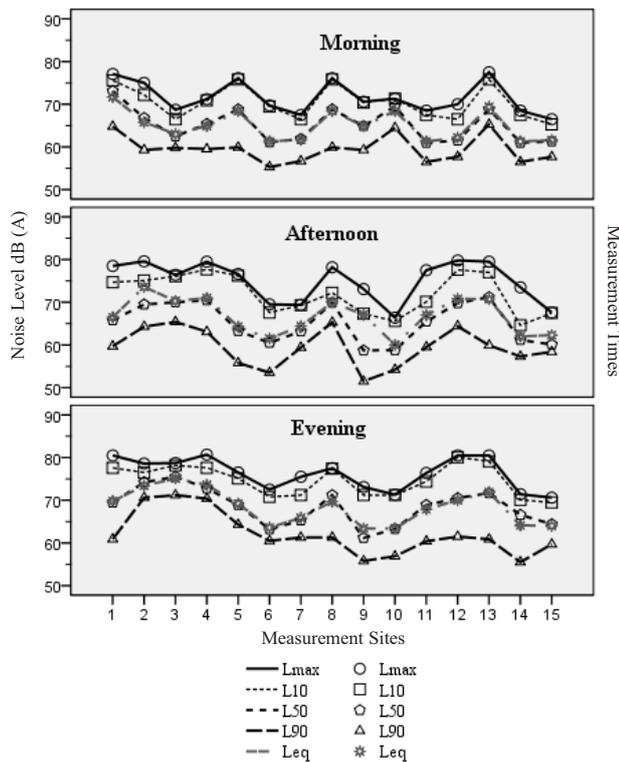


Fig. 3. Average values for L_{max} , L_{eq} , and the statistical levels of L_{10} , L_{50} , and L_{90} in various times.

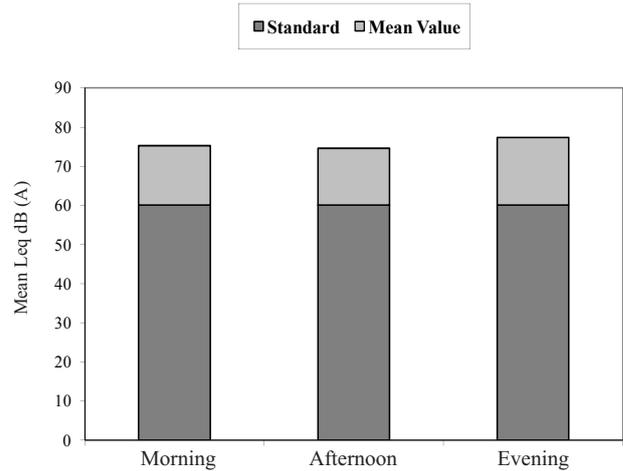


Fig. 4. The mean value of L_{eq} in sampling locations in different times in comparison with standard value.

Discussion

Noise pollution is still considered a big social problem in most major cities in the world. According to the measurements of the sound levels and traffic velocity, it was determined that the sound levels in Yazd are more than the acceptable standard levels. The L_{eq} was in the range between 75.1 dB(A) and 61.3 dB(A). The mean L_{eq} in the residential-commercial areas of Yazd during the day was 66.7dB(A) and during the evening was 68.3 dB(A), which means were 6.7 dB(A) and 8.3 dB(A) higher than the standard levels, respectively.

The results of the present study are in agreement with the results of the Egyptian study [12]. In the study conducted by Nejadkoorki et al., in the city of Yazd in 2009, the mean sound level was 74.4dB(A) (L_{Aeq}). In other similar studies conducted in other cities of Iran, the sound pollution levels were above standard limits (60dB(A)) [13]. In the studies by Li et al, [14], Brown and Bullen et al., [15], and Ali [16], the mean sound levels were above standard acceptable levels. In the study in Curitiba and Brazil on the sound levels over 2 hours in 1000 points of the city, it was determined that 93.3% of the total areas had sound levels exceeding 65 dB(A) and 40.3% of the areas had sound levels more than 75 dB(A) [17].

The TNI and NPL in the present study were 78.2 and 78.6, respectively. Using ANOVA test, there was no statistically significant relationship between these two indices ($P=0.06$).

In the present study, the L_{10} , L_{50} , and L_{90} during a period of 24 hours were 71.2, 66.2, and 60.3, respectively. This depicts the high levels of background noise in Yazd city and L_{max} in the city was 74.3 dB(A) and mean L_{eq} was 66.7dB(A). Golmohammadi et al., in their study in the city of Hamadan, Iran, concluded that the mean sound level in the city was 69.04 dB(A). In another similar study in 2009 conducted by Al-Ghaonamy on four points of Saudi Arabia, the sound level was 70 dB(A) and the L_{10} , L_{50} , and L_{90} were

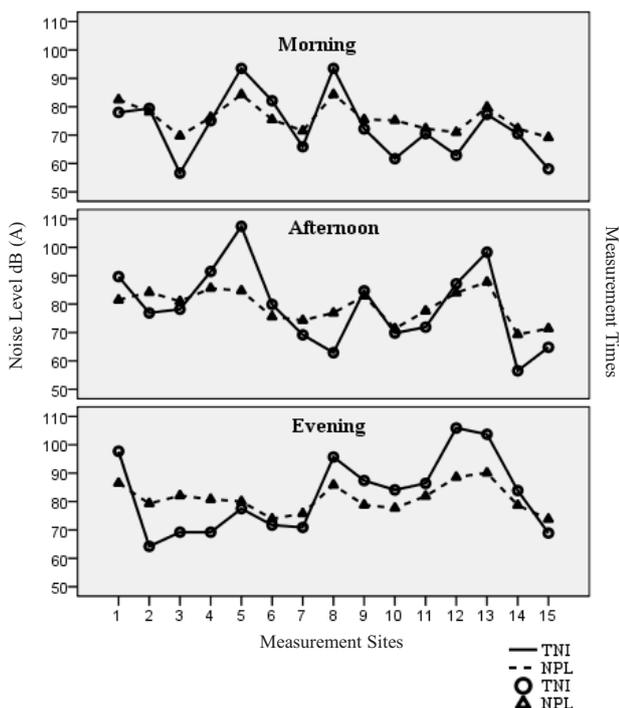


Fig. 5 Comparison of the mean of Traffic Noise Indices (TNI) and Noise Pollution Levels (NPL) in areas under study during three time periods of the day.

75.3, 66.3, and 54.5, respectively [18, 19]. In the study by Serkan Ozer on 65 points of Erzurum city in 2009, the sound levels exceeded 65 dB(A) in 50 of the 65 points (76.9%), while in 25 points (23%), the levels were less than 65 dB(A) [20]. In the study by Yilmaz in 2005, the sound levels were within normal limits [21].

There was no statistically significant difference between the amounts of equivalent sound levels in the evening, morning, or afternoon with P values of 0.49 and 0.72, respectively. There was a statistically significant difference between L_{max} in the afternoon and evening ($P = 0.018$), but there was no significant difference in the levels in the morning and evening ($P = 0.702$). Since Yazd has

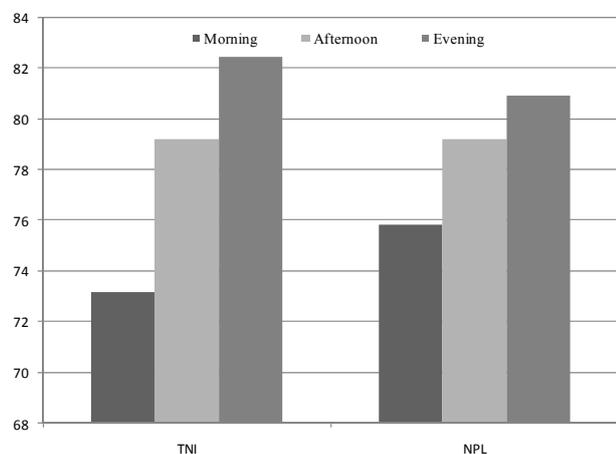


Fig. 6. Comparison of the mean of Traffic Noise Indices (TNI) and Noise Pollution Levels (NPL) in 15 areas of Yazd city.

dry and hot weather conditions, residents usually attend in street in the early or late hours of the day. Therefore, the maximum sound levels are more in the morning and evening as compared to the afternoon.

In another study in the city of Messina, Italy, the equivalent sound levels in the city were 75 dB(A). As a consequence, more than 25% of the residents were distressed because of traffic noise pollution. There was heavy traffic on the main roads of the city during the day time. Furthermore, the sound level was related to the structure as well as transport systems of the city and it was determined 10dB(A) more than the Italian standards [22]. Factors that are effective at reducing sound levels include city building and traffic engineering, though these were the reasons mentioned for the causes of traffic noise pollution in the city [12].

Considering the results of the study, it seems that the sound pollution in Yazd is related to old buildings, as the inappropriate condition in urban streets was the most reason for noise pollution in Yazd. Old vehicles with poor maintenance and bad driver habits also were important. Most noisy vehicles in Yazd are motorbikes, which are old and are not well maintained. Motorcycles produce according to Euro I standard in Iran, but these canonical motors lose standard criteria in a short time. Unfortunately, motor drivers are not obligated to receive technical examinations, so these motorbikes will produce high pollution in Yazd.

Conclusion

Removal of old motor vehicles (especially motorbikes) along with obstacles of city roads is a factor that can influence noise pollution levels on the streets. Other measures include: creation of green belts, traffic management, altering and widening roads, obligation for taking technical examination for motorbikes, sound barriers in order to absorb sound, removal of industrial and commercial centers from the city limits in order to decrease sound pollution, managing one way traffic on streets, and acoustic insulation of buildings.

Acknowledgements

The authors must thank all of our colleagues in collecting data. Also, the research vice chancellor of Shahid Sadoughi University of Medical Sciences is appreciated for supporting and granting this study.

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