Evaluation of Traffic Noise Pollution in Al-Hilla City

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Abstract

The major source of noise in major cities are motorized road vehicles; it is responsible for creating annoyance among people. The main objective of this study is to evaluate and analyze road traffic noise in Al-Hilla City-Iraq. Digital sound level meters with frequency weighting networks were used in this study. All measurements were taken on an A weighting frequency network, at a height of about (110-120) cm from ground and on fast range time weighting. Noise levels have been measured at 48 major locations of the city from 7.00 am to 7.00 am in the next day at the working days. It is observed that at all the locations the level of noise remains far above the acceptable limit for all the examined time period. A safe distance between 60-75m seems to be suitable for all roads, except the Sixty-Street main road. The noise perception survey indicated that 88% of respondents were not satisfied about the noise level in their place and 24% of them suffered from health problems related with noise pollution.

Key words: Pollution, Traffic noise, Measurements of noise pollution, Noise limits.

الخلاصة:

تعد المركبات على الطرق المصدر الرئيسي للضوضاء في المدن الكبيرة وهي مسؤولة عن خلق الانزعاج بين الناس. الهدف الرئيسي من هذه الدراسة هو تقييم وتحليل ضوضاء حركة المرور في مدينة الحلة. استخدم Digital sound level(meters) في هذه الدراسة. تم اخذ جميع القياسات باستخدام (A weighting frequency network و Fast range time weighting)، على ارتفاع حوالي (110–120) سم من الأرض وعلى نظام (fast range time weighting). وقد تم قياس مستويات الضوضاء في 48 موقعا رئيسيا في المدينة من07:00 صباحا حتي 07:00 من صباح اليوم التالي خلال أيام العمل. لوحظ أنه في جميع المواقع، لا يزال مستوى الضجيج أعلى بكثير من الحد المقبول لجميع الفترة الزمنية التي تم فحصها. وتبين أن المسافة الامنة هي بين 60–75متر مناسبة لجميع الطرق ما عدا شارع 60 الطريق الرئيسي. وأشار المسح الضوضائي أن 88٪ من المشاركين كانوا غير راضين عن مستوى الضوضاء في اماكنهم علما ان 24٪ منهم يعاني من مشاكل صحية ذات صلة مع التلوث الضوضائي.

الكلمات المفتاحية: التلوث والضوضاء حركة المرور، و قياسات التلوث الضوضائي ، وحدود الضوضاء

1. Introduction

One of the most undesirable side effects of improperly planned industrialization is the pollution of our environment and consequent degradation of the quality of life. Noise pollution is a significant environmental problem in many rapidly urbanizing areas. This problem is properly not recognized despite the fact that it is steadily growing in developing countries. It is well established now that noise is a potential hazard to health, communication and enjoyment of social life. It is becoming an unjustifiable interference and imposition upon human comfort, health and quality of modem life (Murthy *et. al*.,2007). Traffic can be considered as the main source of noise pollution in large cities (Al-Ghonamy, 2010).

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 without harmony (Patroescu and Ioja, 999), Studies have shown that some of the most pervasive sources of noise in our environment today are those associated with transportation (U.S. Department of Transportation, 1995).

The noise of road vehicles is mainly generated from the engine and from frictional contact between the vehicle, the ground and air. In general, road-contact noise exceeds engine noise at speeds higher than 60 km/h. The physical principle responsible for generating noise from tire road contact is less well understood. The sound pressure level from traffic can be predicted from the traffic flow rate, the speed of the vehicles, the proportion of heavy vehicles, and the nature of the road surface.

Special problems can arise in areas where the traffic movements involve a change in engine speed and power, such as at traffic lights, hills, and intersecting roads; or where topography, meteorological conditions and low background levels are unfavorable (for example, mountain areas) (Murthy *et. al*., 2007).

The level of highway traffic noise depends on three things: (1) the volume of the traffic, (2) the speed of the traffic, and (3) the number of trucks or other excessively loud vehicles in the traffic stream. Generally, the loudness of traffic noise is increased by heavier traffic volumes, higher speeds, and greater numbers of trucks and other noisy vehicles. Vehicle noise is a combination of the noises produced by the engine, exhaust, and tires. The loudness of traffic noise can also be increased by defective mufflers, other faulty equipment on vehicles, or after-market devices installed on vehicles to intentionally increase vehicle noise. In addition, there are other more complicated factors that affect the loudness of traffic noise. For example, as a person moves away from a highway, traffic noise levels are reduced by distance, terrain, vegetation, and natural and manmade obstacles (NCTF, 2005).

2. Description of Studied Area

Al-Hilla city is the center of Babylon governorate and is located near the ancient cities of Babylon, on Shutt Al-Hilla branch of the Euphrates River, 100 km south of Baghdad. Al-Hilla city is a main stop for trucks and buses traveling from neighborhood areas. It is situated in a predominantly agricultural region which is extensively irrigated with water provided by Al-Hilla canal. The city was once a major center of Islamic scholarship and education. Population density of Babylon government is about 326 persons/km^2.

3. Traffic Noise in Al-Hilla City

3.1 Distribution of Measurements Stations

The main objective of this study is to measure the environmental noise levels and assess the noise pollution in Al-Hilla city predominantly due to traffic mobility. This exercise also gives an opportunity for a comparative assessment of noise level associated near houses and at main and link roads. Besides the environmental noise measurement public opinion survey was conducted about traffic noise pollution and its health effect.

Most of the houses, shops and other important commercial offices of Al-Hilla city are located along the link and main roads, so the study area is divided into seven measurement stations as shown in Figure (1). These stations are located at the main and link roads in the study area and located at the start and the end of Forty-Street link road, Sixty-Street main road, Hilla-Baghdad main road, Hilla-Najaf main road, Hilla-Karbala main road, and Hilla-Diwaniyah main road which is pointed as 1, 2, 3,4,5,6, and 7, respectively. Each station measurement consists of six spots 0, 15, 30, 45, 60 and 75 meters, which represents the distance far from the side of the main or link road (station) under consideration. These stations covered all the concerned areas of Al-Hilla city which are affected by traffic noise. At each spot, a minimum of 20 and a maximum of 56 noise measurements are taken at four different times from 7.00am – 7.00am (during 24 hours). All the measurements are taken under controlled conditions to minimize the influence of horns, sirens from emergency vehicles and other noises.

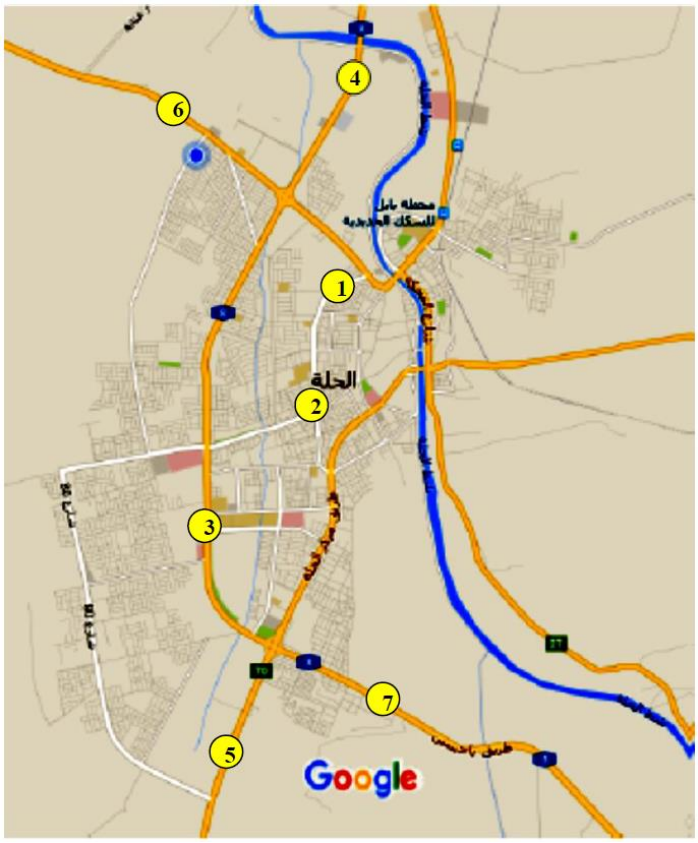

Figure (1): Distribution of the measurement stations in Al-Hilla city

3.2 Instrumentations and Measurements

The noise levels are measured with the help of a digital sound level meter with the frequency weighting networks (Model-407732 Version 1.4, made in USA). A linear frequency range of 31.5 Hz to 8 KHz and a dynamic range of 35 to 130dB were applied. This instrument is shown in Figure (2). Type 407732 Acoustic calibrator was used to calibrate the sound level meter at a referenced level of 94 dB before and after taking field measurements. All measurements were taken on an A weighting frequency network, at a height of about 110-120 cm from ground and on a fast range time weighting. The A weighting characteristics and fast range simulated the human ear listening response. All measurements were carried out during working days and under suitable climatic conditions. Table (1) shows the maximum permissible noise limits in dB (A) and Table 2 shows the noise risk zone criteria adopted to be used in this study (Al-Ghonamy, 2010).

Figure (2): Digital sound level meter (Model-407732, Version 1.4)

Table (1): Maximum permissible noise limits in dB (A) (Al-Ghonamy, 2010)

Type of area	Day (07.00-22.00)	Night (22.00-07.00)
Residential	55	45
Commercial-residential	60	50
Commercial	65	55
Industrial- residential	70	60
Industrial	75	65

Table (2): Noise risk zone criteria adopted to be used in this study (Al-Ghonamy, 2010)

Intensity of noise in dB(A)	Zones
Less than 66	Safe
66-71	Tolerable
71-76	Low risk
76-81	Moderate risk
81-86	High risk
Greater than 86	Extremely high risk

4. Methodology

The parameter universally used in discussions of noise pollution of environmental is L_{eq}, the energy equivalent continues noise level expressed in dB(A) which is the average rate at which energy is received by the human ear during the period mentioned (Jobair *et. al*.,2001). This parameter can be obtained by direct objective measurement with an integrating type of sound level meter; or can be computed from a sample record of variation of noise level with time during a specified period. Mathematically it can be expressed as follows:

$$L_{eq} = 10\ Log_{10}\left[\frac{1}{T}\int_0^T \frac{f^2}{f_0^2}dt\right] \qquad \ldots (1)$$

$$L_{eq} = L_{50} + \frac{(L_{10} - L_{90})^2}{60}$$

Where T is the period of measurement. It is quite common to calculate L_{eq} values separately for day- and night-time periods. Where L_{10}, L_{50}, and L_{90} indicate the levels exceeded for 10%, 50% and 90% of time respectively in a set of records of noise level in a given interval of time (Kudesia *et. al*., 1993/94).

Another parameter, termed as Noise Pollution Level L_{np}, is also used to express varying level of noise. It can be computed from the time varying noise level using the following equation (Jobair *et. al*., 2001):

$$L_{np} = L_{50} + \frac{(L_{10} - L_{90})^2}{60} + (L_{10} - L_{90}) \qquad \ldots (2)$$

The parameter L_{np} takes into account the variations in sound signal and hence serves as better indicator of noise pollution in the environment of physiological and psychological disturbance of the human system. L_{np} is expressed in the units of dB (A).

The day night equivalent noise levels of a community (L_{dn}) can be expressed as:

$$L_{dn} = 10\ Log_{10}[15/24(10^{L_d/10}) + 9/24(10^{(L_n+10)/10})] \qquad \ldots (3)$$

Where L_d is the day-equivalent noise levels (from 07.00 - 22.00), dB (A) and L_n is the night equivalent noise levels (from 22.00 - 07.00), dB (A) (Kudesia *et. al.*, 1993/94).

Traffic Noise Index (TNI) is another parameter which indicates the degree of variation in a traffic flow. This is also expressed in dB (A) and can be computed by using the following equation:

$$TNI = L_{90} + 4(L_{10} - L_{90}) - 30 \quad \ldots (4)$$

Noise Climate (NC) is the range over which the sound levels are fluctuating in an interval of time and is given by the following equation (Kudesia et al., 1993/94):

$$NC = L_{10} - L_{90} \quad \ldots (5)$$

5. Results and Discussion

This study was carried out to evaluate the traffic noise pollution in Al-Hilla city. The diurnal average noise index values for mixed (residential-and-commercial) stations in Al-Hilla city is listed in Table (3-a) and (3-b) for Day 07:00-22:00 and Night 22:00-07:00, respectively. For all stations measurement, the day-night average sound level L_{dn} exceeded the maximum permissible limit of 55.0 dB (A) set by the European Union (EU). It can be observed that the average level of noise and its degree of fluctuation, as implied by L_{eq}, L_{10}, L_{50}, L_{90}, L_{max}, L_{np} and TNI, are high in all stations, also the range of variation in noise level is much higher as implied by the values of noise climate (NC). Table (4) in conjunction with Figure (3) and (4) show that the average L_d values at all spots in each station measurement exceeded the maximum permissible limit for link roads at a distance less than 30m, and for main roads at a distance less than 75m from the road, but the average L_n for link and main roads is acceptable between 60-75m from the road.

Table (3-a): Diurnal average noise index values at Day 07:00-22:00

Station	L_{eq}	L_{10}	L_{50}	L_{90}	L_{max}	L_{np}	TNI	NC
1	69.2	72.5	67.5	62.5	80.4	79.2	72.5	10.0
2	70.7	75.0	69.5	66.5	83.0	79.2	70.5	8.5
3	80.5	83.6	78.8	73.6	87.0	90.5	83.6	10.0
4	77.3	79.6	76.6	73.2	88.9	83.7	68.8	6.4
5	75.1	78.2	74.0	70.2	87.2	83.1	72.2	8.0
6	77.5	80.8	76.2	71.9	89.9	86.4	77.5	8.9
7	78.8	81.6	77.4	72.6	90.2	87.8	78.6	9.0

Table (3-b): Diurnal average noise index values at Night 22:00-07:00

Station	L_{eq}	L_{10}	L_{50}	L_{90}	L_{max}	L_{np}	TNI	NC
1	65.9	67.5	65.4	62.0	79.5	71.4	54.0	5.5
2	68.5	71.8	67.5	64.0	76.4	76.3	65.2	7.8
3	76.8	79.2	76.4	74.2	86.0	81.8	64.2	5.0
4	69.5	73.4	68.8	66.8	86.6	76.1	63.2	6.6
5	71.6	73.8	71.0	68.0	85.6	77.4	61.2	5.8
6	70.3	72.6	69.9	68.0	85.9	74.9	56.4	4.6
7	70.5	74.2	69.8	67.8	86.1	76.9	63.4	6.4

Table (4): Average L_d and L_n values in main and link roads

Station	Distance from road side (meter)											
	0		15		30		45		60		75	
	L_d	L_n	L_d	L_n	L_d	L_n	L_d	L_n	L_d	L_n	L_d	L_n
1	69.2	65.9	61.7	58.0	56.3	56.4	55.9	57.4	53.8	54.5	50.9	48.8
2	70.7	68.5	64.5	61.2	58.7	56.4	54.7	52.9	52.4	51.2	50.4	48.8
3	80.5	76.8	71.5	71.2	68.2	68.9	63.5	64.1	60.9	62.5	59.3	60.0
4	77.3	69.5	70.4	63.0	65.9	57.7	61.1	56.0	58.3	51.5	53.5	49.1
5	75.1	71.6	68.4	65.6	67.1	61.9	64.0	59,4	62.1	54.6	59.8	51.8
6	77.5	70.3	68.4	65.7	63.5	61.3	59.3	59.3	57.5	52.3	53.3	49.3
7	78.8	70.5	74.5	65.6	64.3	61.0	60.4	57.6	58.5	54.3	55.6	49.8

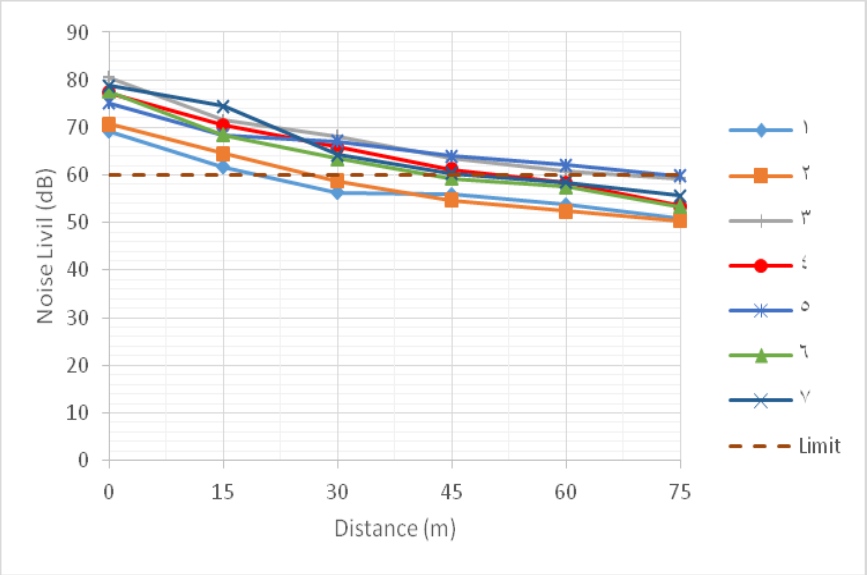

Figure (3): Average L_d values at different distances

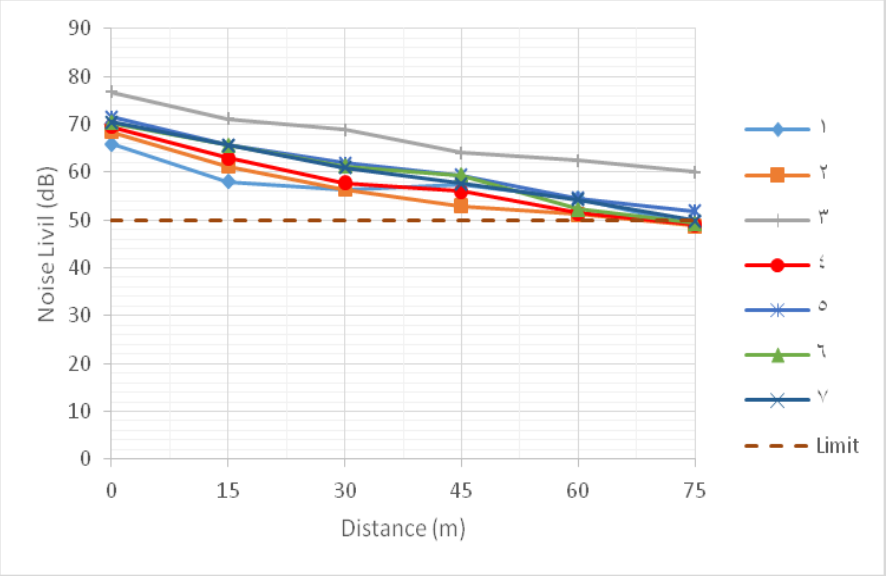

Figure (4): Average L_n values at different distances

The average traffic load in the central intersections of Al-Hilla city were computed by using a digital camera (Sony DSC-W310,12.1mega pixels) in each junction for one hour and the results are shown in Table (5). Road traffic volumes at those intersections explain the reason behind the high level obtained. Using the noise risk zone criteria shown in Table (2) to assess the situation of Al-Hilla city station led to the classification shown in Table (6).It should be noted that all the stations in the studied area are not safe. Low risk was observed for the Start and End of Forty-Street link road, and Moderate risk for Hilla-Baghdad, Hilla-Najaf, Hilla-Karbala, and Hilla-Diwaniyah main roads. High risk goes to Sixty-Street main road.

Table (5): Average traffic load in Al-Hilla city

Station	Traffic Load (per hours)
Start of Forty-Street link road	2618
End of Forty-Street link road	2042
Sixty-Street main road	4273
Hilla-Baghdad main road	1933
Hilla-Najaf main road	2116
Hilla-Karbala main road	2702
Hilla-Diwaniyah main road	1974

Table (6): Classification of district of Al-Hilla city

Station	L_{dn}	Zones
Start of Forty-Street link road	73.0	Low risk
End of Forty-Street link road	75.3	Low risk
Sixty-Street main road	84.0	High risk
Hilla-Baghdad main road	78.3	Moderate risk
Hilla-Najaf main road	78.7	Moderate risk
Hilla-Karbala main road	78.8	Moderate risk
Hilla-Diwaniyah main road	79.5	Moderate risk

6. Perception Study

The noise perception survey carried out by a questionnaire administered to 234 individuals in Al-Hilla city indicated that most of respondents were aware about noise pollution but their health significance was not fully realized. It was found that the 88% respondents were not satisfied about the noise level in their place. Headache, bad temper, hearing problem, loss of concentration, fatigue, neurosis, depression, anxiety, distraction and increasing the stress levels among people were some of the significant effects manifested by noise pollution. Also, 66% of respondents suffered from headache as the main health effect of noise pollution and 24% of them visited health care centers for treatment of health problems related to noise pollution.

7. Conclusions and Recommendations

The main objective of this study is to analyze and to evaluate road traffic noise in Al-Hilla City from which the following conclusions can be drawn based on the above results:

1. For all stations measurement, the day-night average sound level L_{dn} exceeded the maximum permissible limit.
2. The average level of noise and its degree of fluctuation, as implied by L_{eq}, L_{10}, L_{50}, L_{90}, L_{max}, L_{np} and TNI, are high in all stations, also the range of variation in noise level is much higher as implied by the values of noise climate (NC).

3. A distance between 60-75m seems to be suitable for all roads, except the Sixty-Street main road.
4. Using the noise risk zone criteria indicates all the studied area are not safe, especially for Sixty-Street main road which is classified as High risk for the surrounding residential areas.
5. The noise perception survey indicated that 88% respondents were not satisfied about the noise level in their place and 24% of them suffered from health problems related with noise pollution.

The situation is of such dire proportions that urgent action needs to be taken to contain and where necessary, reverse the problem. To reduce noise pollution, several measures can be implemented which include:

1. Proper maintenance of vehicle and roadway may reduce the noise levels.
2. Plantation of trees and construction of sound barriers have a positive effect on noise levels.
3. Town planning needs to study the distribution of main and link roads with respect to residential areas and identify places where new roads and overpasses can be built. This can lower traffic volumes and decongest the streets.
4. Public awareness program needs to be established to educate the public in the city about the negative health side effects emanating from prolonged exposure to high noise levels.

8. References

Al-Ghonamy, A.I. ,2010,."Analysis and Evaluation of Traffic Noise in Al-Dammam a Business City of the Eastern Province of KSA". Journal of Environmental Science and Technology 3(1): 47-55. ISSN 1994-7887.

Duffour, P.,2006," Noise Pollution", Lecture Notes E216.UCL Department of Civil and Environmental Engineering.

Jobair Bin Alam, M., Rauf, A.F., Ahmed, M.F.(2001)."Traffic Induced Noise Pollution in Dhaka City", Journal of Civil Engineering. The Institution of Engineers, Bangladesh. Vol. CE 29, No. I.

Kudesia,V.P and Tiwari, T. N, 1993/94,“Noise pollution and its control”, Pragati Prakashan, Meerut, India.

Murthy, V.K., Majumder, A.K., Khanal, S.N., and Subedi, D.P., 2007,."Assessment of Traffic noise Pollution in Banepa, a Semi Urban Town of Nepal”, Kathmandu University. Vol. I, No. IV.

Washington County Noise Control Task Force (NCTF), Final Report. Volume II. Resource Documents. Subcommittee report for the Committee for Citizen Involvement Representing the Citizen Participation Organizations of Washington County, Oregon. "Promoting the protection of community livability through effective noise control”. July 2005.

Patroescu, M. and Ioja, C., 1999,"Noise pollution generated by road traffic in Bucharest”, University of Bucharest, Centre for Environmental Research, Bucharest, Romania.

U.S. Department of Transportation, Federal Highway Administration ,1995, "Highway traffic noise analysis and abatement policy and guidance ", Office of Environment and Planning Noise and Air Quality Branch Washington, D.C.