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Noise Pollution in Urban Environments: a Study in Al-Samawah City, Al-Muthanna, Iraq

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ABSTRACT

Noise generally is known as unwanted and unwelcome sound. It is considered as the most pervasive pollutant besides the emission pollutants. Along with the increasing degree of air and water pollution, noise pollution is also emerging as a new threat to the inhabitants of Al-Samawah city. Al- Samawah city experienced rapid development and high influx of people with the implication of increased generation of noise. Hence the need to evaluate the noise pollution level of the city. Measurement of noise pollution level was carried out in 20 locations around the city using a GM1351 digital sound level meter with a range of 30-130 dB. Day-time urban noise quality assessment was studied in Al-Samawah city for six critical zones viz. Industrial , Commercial, Residential, Recreational ,Silence zone and Traffic areas. Noise pollution indices viz. L10, L50, L90, noise climate (NC), equivalent continuous noise level (Leq) and noise pollution level (Lnp) were computed for all zones. Excel's computer program used for fitting model equations to the obtained experimental data. Results indicated that the highest Leq of 72.5 dB in the industrial zone followed by 70.0 dB in traffic areas ,68.1 dB was observed in commercial zone, 65.2 dB in residential zone ,63.5 dB in silent zone, and 62.4 dB in recreational zone. For commercial zones, Leq observed were down the statutory limits, while for other zones it was above the WHO limits. The noise assessment study clearly revealed that the Industrial and residential zones caused noise pollution in Al-Samawah city and silence areas need attention and care from the institutions to be silent zones. As excessive noise affects health of people deleteriously, the establishment of an agency under the name of Iraqi Environmental Protection Agency (IEPA) is essential for controlling this and similar hazards.

Introduction

Noise is derived from the Latin word “nausea” implying ‘unwanted sound’ or ‘sound that is loud, unpleasant or unexpected [1]. Noise is present in every human activity, and when assessing its impact on human well-being it is usually classified either as occupational noise (i.e. noise in the workplace), or as environmental noise, which includes noise in all other settings, whether at the community, residential, or domestic level e.g. traffic, playgrounds, sports, music [2]. Noise pollution is a significant environmental problem in many urban areas. This problem has not been properly recognized despite the fact that it is steadily growing in developing countries[3] .Undoubtedly, the most important source of noise pollution in urban areas is related to road vehicles [4]. Hearing is one of the most important of the human senses. It is essential for the location of sounds that may warn of danger, the enjoyment of pleasant sounds such as music and the natural environment and, most importantly for humans, the development of speech and language for communication [5]. The World Health Organization (WHO) states that there is sufficient evidence that night noise exposure causes self-reported sleep disturbance and noise induced sleep disturbance is viewed as a health problem. WHO also state there is evidence, albeit limited, that disturbed sleep causes fatigue, accidents and reduced performance [6]. There is also some evidence that noise can adversely affect general health and well being in the same manner as chronic stress [7]. Many surveys addressing the noise pollution problems has been conducted for several cities of the world [8]. and have clearly shown the scale of discomfort that noise causes in people’s lives [9].The effects of noise on human health and comfort are divided into four categories depending on its duration and volume. They are: (1) physical effects such as hearing defects; (2) physiological effects, such as increased blood pressure, irregularity of heart rhythms and ulcers; (3) psychological effects, such as disorders, sleeplessness and going to sleep late, irritability and stress; and (4) effects on work performance, such as reduction of productivity and misunderstanding what is heard [10]. Therefore, assessing the problem and programming actions for controlling noise and its adverse effects have become an issue of immediate concern for community.

Previous Studies and Researches

Jeba Rajasekhar RV, etc.al (2005) estimated either noise levels exceed or are about to cross the permissible standards at most of the sampling sites of current concern in the city. In addition, a simple noise model in the current assessment predicts the ambient noise level Leq and the predicted values are compared with the experimental noise levels. As the predicted values are in reasonable agreement with the estimated values of noise levels, it can be concluded that the modeling equations of present study can be used to predict the noise levels all over the city [11]. Pachpande BG, et.al (2005) reported that the hearing status and audiometric analysis of school teachers and students was collected from the schools located in the near vicinity of

NH-6 passing through Jalgaon city. About 84% teachers and 92% students have reported hearing difficulty in the questionnaire. In the audiometric testing mild hearing loss (25 to 35 dBHL) was observed in both the subject groups. The strategies need to adopt for protection of the teachers/students from the noise exposure are suggested [12]. Banerjee D, etc.al (2006) revealed that nighttime noise levels (10.00 pm - 6.00 am) in all the locations exceeded the limit prescribed by Central Pollution Control Board. The daytime noise level was much higher at all locations in respect to the nighttime noise level. The Day-Night equivalent noise level (Ldn) was determined and ranged between 67.16 dB (A) and 89.44 dB (A) [13]. Kisku GC, etc.al (2006) Studied 12 locations with sound level meter to assess day time and night time noise levels of Lucknow city. In residential areas, noise ranged between 67.7 to 78.9 and 52.9 to 56.4; in commercial cum traffic areas 74.8 to 84.2 and 68.2 to 74.9 and in industrial areas 76.9-77.2 and 72.2-73.1 dB (A) during day and night time respectively, Values were higher than their prescribed standards, which may pose a significant impact on quality of life[14]. Thakur Gulab Singh, etc.al (2006) discussed the results of a study undertaken to assess the noise levels at the major traffic junctions and community area near an educational institution of an urban city. Noise equivalent level Leq and the statistical levels L10, L50, L90 were measured in the neighborhood community areas as well as at the traffic junctions. The study indicates a need for proper land-use planning when traffic corridors are built in the silence zone areas[15]. In 2011, Kusag, Hirrat and Mousa provided papers presents the noise pollution in Al-shaheed Copper and Brass factories in Iraq. The factories are staffed by 1700 workers for 12 hours a day, 7 days a week. This study depended on the maximum permissible occupational noise exposure limit of International Standards Organization (ISO) and Occupational Safety Health Act (OSHA) as a comparison reference. And proved that the half of the work sites in factories where unacceptable noise levels and all sites of comfort workers exceeded the limit of acceptable noise and the study also proved that the administration building factories sites within the levels of the noise surveys and administrative staff in safety from the impact of noise in factories. Also the Noise pollution has no effect on residential areas near the factories[16].

Objective of Study

Nowadays, the concern about the acoustic pollution is acquiring considerable importance. The characteristics of noise contamination are not the same all over the world. These depend on such factors as the degree of development, the kind of activities involved, the population density, increasing number of vehicles, and even local habits and culture, etc. The noise pollution is importance as a stressing and possibly even dangerous affecting human life, Therefore, this study aims to measure levels of environmental noise (indoor and outdoor) in large and small side of Al-Samawah city then compare with the permissible health standards WHO (World Health Organization) to create appropriate dwelling conditions for citizens as well as put some future recommendations for use when creating new buildings or open new colleges or commercial centers , roads etc.

Concept of Noise Pollution

Noise is defined as any unwanted signal and in most cases the signal is nothing but sound. The extent to which noise is annoying depends on many factors such as the pitch irregularities, duration, rhythm and unexpectedness or whether the noise has any meaning for the particular observer[17].The term Noise has been defined as a sound without agreeable musical quality or as an unwanted or undesired sound. Noise is no less a pollutant than the toxic chemicals in the environment. As a result of increasing mechanization, the use of increasingly voluminous and complicated machinery and equipment and the stepping up of the pace of production, the noise is becoming an increasingly wide- spread and serious source of discomfort and danger. Definition given in the ILO Convention No. 148 is the term noise covers all the sound, which can result in hearing impairment or be harmful to health or otherwise dangerous[18]. Noise as pollution is said to occur when the noise level is above the maximum permissible level for a given environment (WHO, 1980 and FEPA, 1991). It is also defined as the addition of sound to the environment beyond the natural sources and measured in intensity, duration and frequency of occurrence[19]. Noise as a polluting agent in the environment has been recognized for some time as a serious threat to the quality of life enjoyed by the populace [20]. The most important measurement of noise is its loudness. This loudness depends on the physical sound pressure that is measured on the sensitivity of the human ear to it. The sensitivity of the human ear depends on the frequency of the sound [21]. Though noise pollution is a slow and subtle killer, yet very little efforts have been made to ameliorate the same. It is, along with other types of pollution has become a hazard to quality of life. Kiernan finds that even relatively low levels of noise affects human health adversely. It may cause hypertension, disrupt sleep and/or hinder cognitive development in children[22]. The effects of excessive noise could be so severe that either there is a permanent loss of memory or a psychiatric disorder [23]. Thus, there are many an adverse effects of excessive noise or sudden exposure to noise. Some of the ways to reduce noise in an area includes putting on hearing aids [21], the use of exhaust silencer [24] and planting of trees and shrubs in front of buildings [25]. Noise has been proved to contribute to the decrease in working efficiency and an increase in the ability to make mistakes[26, 27 and 28]. The unit of sound intensity measurement is decibel (dB) and each decibel rise depicts ten-fold increase in sound intensity. The permissible noise tolerance levels are displayed (Table 1).

Table 1. WHO Community Noise Guidance[29]

Environment	Critical health	Effect Sound level dB	Time hours
Outdoor living areas	Annoyance	50 – 55	16
Indoor dwellings	Speech intelligibility	35	16
Bedrooms	Sleep disturbance	30	8
School classrooms	Disturbance of Communication	35	During class
Industrial, commercial and traffic areas	Hearing Impairment	70	24
Music through earphones	Hearing Impairment	85	1
Ceremonies and entertainment	Hearing impairment	100	

Materials and Methods

Study Area

The present investigation on evaluation and analysis of environmental noise pollution was conducted in the city of Al-Samawah during the period of winter season (December to February 2014-2015). The city of Al-Samawah is the modern capital of the Al Muthanna Governorate. The city is located midway between Baghdad and Basra, at the northern edge of the governorate. The province was established in 1975; prior to that date it was a unified province along with Qadissiya (Diwaniya)

and Najaf. It has a population of 776 298 people according to the 2006 census [30]. It is located at an elevation of 9 meters above sea level. Its coordinates are 31°24'0" N and 45°24'0" E in DMS (Degrees Minutes Seconds) or 31.4 and 45.4 (in decimal degrees). This study was conducted at twenty different locations in the Al-Samawah city. For this purpose six zones: industrial, commercial, residential, recreational, road and intersections near residential zones and silence zone were selected within the city. Figure.1 shows the study area.

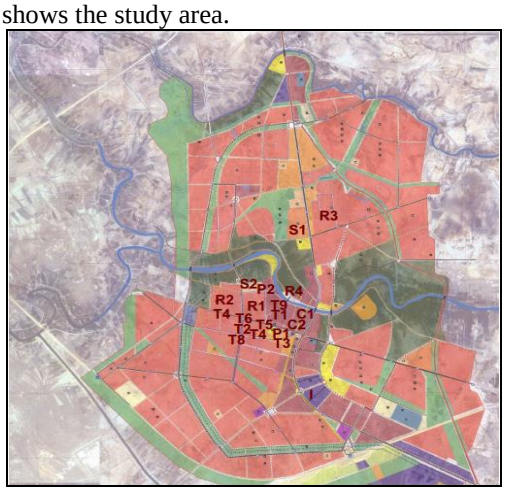

Figure 1. Map of Al-Samawah city showing six noise assessment zones

Noise Sampling:

Noise levels in 'A' weighting network were measured using Digital Sound Level Meter (GM1351). For each sampling site, noise measurements were carried out continuously for the period of 50 days with eight hours of monitoring per day with a gap of one hour after every hour of reading. The schedule selected during the day time was as follows: 8.00-9.00 am, 10.00-11.00 am, 12.00-1.00 pm, 2.00-3.00 pm, 4.00-5.00 pm, 6.00-7.00 pm., 8.00-9.00 pm and10.00-11.00 pm. The night readings acted as a control. For each 10 minutes per hour (during one hour 6 reading), the noise levels were recorded after two minutes. The data collected from each place was processed for statistical analysis. The sound level meter was placed at a height of 1.5 meter above the ground level Table 2 shows the six sampling locations/zones of Al- Samawah city that were selected for noise pollution study. The areas which were not covered in this study was the agricultural areas far from the city center and there was no any-noise.

Noise pollution indices

Various noise pollution indices were calculated using Gaussian percentile to obtain the noise pollution levels. Different percentile values like L10, L50 and L90 were computed from the sampled data and these parameters were used for the evaluation of Noise Climate (NC), Equivalent Continuous Noise Level (Leq) and Noise Pollution Level (Lnp) [30]. Following equations were used to compute the noise pollution indices.

$NC = L10 - L90$ ……...(1)

$Leq = L50 + [(NC)^2/60]$ …….(2)

$Lnp = Leq + NC$ …….(3)

Where, NC is Noise Climate; L10 is the level of sound exceeding for 10% of total time of measurement or Peak Noise Level; L50 is the level of sound exceeding for 50% of total time of measurement or Mean Sound Level; L90 is the level of sound exceeding for 90% of total time of measurement or Background or Residual Noise Level; Leq is Equivalent continuous noise level and Lnp is the Noise Pollution Level.

Table 2. Sampling location for noise pollution monitoring in Al- Samawah city

SI.No.	Zone (Location name)	Code*
1	Silence Zone	
	Government University (Al-Muthanna university)	S1
	Government Hospital (Al-Hussain hospital)	S2
2	Commercial zone	
	Al-Samawah Market	C1
	Patta Street	C2
3	Residential zone	
	Teachers Region	R1
	Al-Hussain Region	R2
	Um-Alasafeer Region	R3
	Al-Qishla Region	R4
4	Recreational Zone	
	Amusement park	P1
	Flower Park	P2
5	Traffic Areas	
	Al-Mustafa Street	T1
	Al-Sader Street	T2
	Al-Muhafada Street	T3
	Mahdi Al-Samawi Street	T4
	Al-Waqiaa Street	T5
	Al-Ameer Street	T6
	University Street	T7
	Hassan Atia Intersections	T8
	Al-Garbi Intersections	T9
6	Industrial Zone	
	Industrial Region	I

*S-Sensitive or Silence areas, C-Commercial areas, R-Residential areas, P-Recreational areas, T-Traffic areas and I-Industrial areas.

Results and discussion

Silence Zone

Data in Figure. 2 and 3 depicts the average noise pollution indices viz. Leq, Lnp, L10, L50 and L90 in silence zone of Al-Samawah city at various time intervals (i.e. 8.00 am to 11.00 pm). It clearly shows that the highest L10 observed during the tested period was 74.1 dB between the time period 8.00-9.00 am in Al-Muthanna university. Similarly, the L90 observed was 72.2 dB, while the L50 was 72.9 dB during the time period 12:00-1:00 pm in the same place indicating the maximum noise levels attained in silence zone. Maximum Leq calculated was 73.0 dB between 12.00-1.00 pm, while it was minimum (47.7 dB) during night from 10.00- 11.00 pm in the university. The day time Leq total observed in this zone was 63.5 dB greater than the WHO limits during day time, which is 35 dB, table 4 .This may be attributed to small area of the university, the convergence of colleges, lack of green areas, in addition to present of the restoration works within the university and colleges near the main street. The educational institutions are exposed to very high noise levels, which might cause nuisance to the students in addition to the adverse health effects. Either in Al-Hussein hospital was not in conformity with the values of the specifications and that the absence of a function to prevent noise and keep quiet signs in addition to the lack of furnishings that absorb sound, the lack of open places and spaces within the hospital as well as ambulances voice. Lnp takes into account both NC and Leq indices. It gives an idea of noise pollution with fluctuations in the noise level. It is considered as the best indicator of physiological and psychological impact of noise. The highest observed Lnp was 75.2 during 8.00-9.00 am and 51.3 during the night 10.00-11.00 pm. Table 3 shows the data for NC ,Lnp and Leq for all the six studied zones of Al-Samawah city. NC in Silence zone indicates the greater fluctuations in the noise levels. The maximum NC was 7.2 between 2.00-3.00 pm,

while it was minimum (NC=1.5) between the time period 12.00-1.00 am in Al-Hussein hospital.

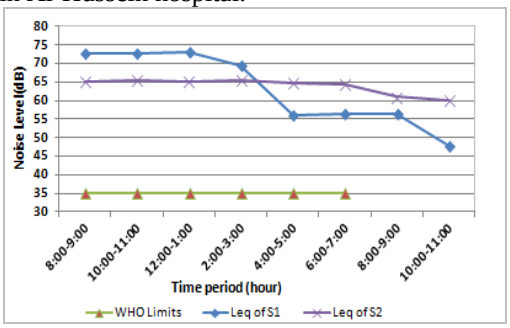

Figure 2. Average ambient noise levels in dB of silence zone

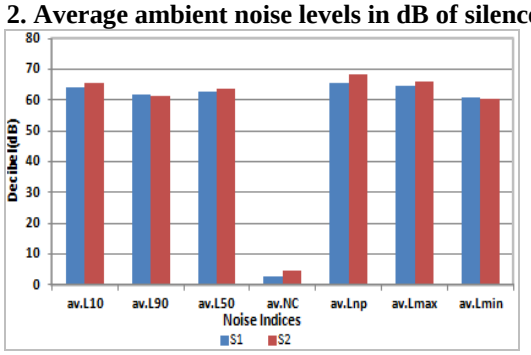

Figure 3. Average noise levels indices in dB of silence zones

Commercial Zone

Figure. 4 and 5 show the noise pollution indices of Commercial zones (Al-Samawah Market and Patta Street). It shows highest L10 during the period between 4.00-5.00 pm (77.6 dB). Similarly, L90 and L50 observed in this zone was 76.7 and 77.0 dB, respectively in Patta Street, indicating maximum noise levels attained between 4.00-5.00 pm. However, the Leq calculated in this zone (range 54.0 to 77.0) during day time. The maximum value was consistently greater than the limits of WHO (70 dB). As mentioned earlier, in commercial area, the highest and lowest Leq observed were 77.0 dB during 4.00- 5.00 pm in Patta street and 54.0 dB in Al-Samawah market during 10.00-11.00 pm, respectively. In the present study, the calculated average Leq was (68.1 dB) below the limits of 70 dB, table 4. The maximum NC in this zone between 10:00 – 11.00 pm was 3.9 and Lnp 78.7 dB.

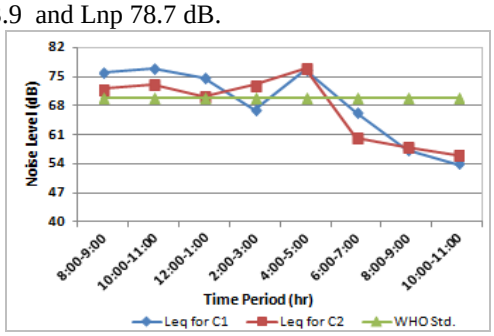

Figure 4. Average ambient noise levels in dB of commercial zones

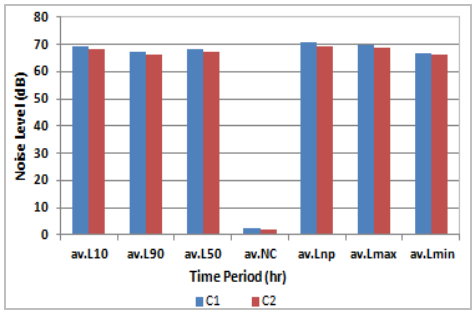

Figure 5. Noise pollution indices in dB of commercial zones

Industrial zone

Figure 6 and 7 depicts the data on noise pollution indices for industrial zone while the data for NC , Lnp and Leq is shown in Table 4 for over a period between 8:00 am to 11:00 pm. It was found that the average L10 value calculated was 97.0 dB between 8.00-9.00 am. Correspondingly, the L50 and L90 values were also higher during the same period indicating that the noise emanated in this zone was maximum during 8.00-9.00 am in the morning. As far Leq in Industrial zone was concerned, it varied from 96.0 - 46.8 dB, the maximum being 96.0 dB between 8.00-9.00 am and the minimum being 46.8 dB between 10.00-11.00 pm. The outdoor noises in industrial area generated by man-made activities. In the present study, the calculated average Leq was (72.5 dB) above the limits of 70 dB. Data in Table 3 shows that maximum NC observed in industrial area was 11.2 between 12.00-1.00 pm.

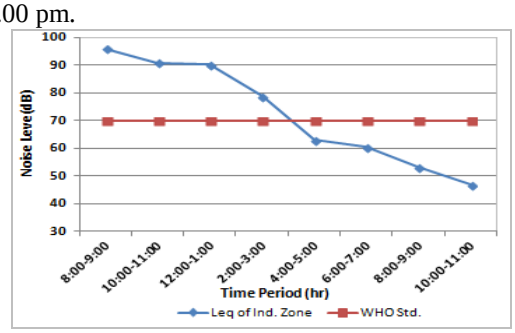

Figure 6. Average ambient noise level in dB of industrial zone

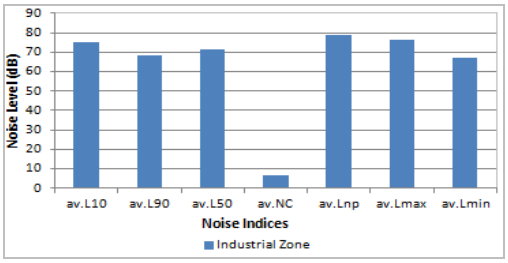

Figure 7. Average noise level indices in dB of industrial zone

Recreational Zone

Noise pollution indices for recreational zone (Amusement park and Flower Park) are shown in Figure 8 and 9, while the data of NC, Lnp and Leq is depicted in Table 3. It can be clearly seen that the corresponding values of L10, L50, L90, Lnp and Leq were higher between the 10:00-11.00 am, 76.1dB ,73.7dB and72.4dB at the time 8:00-9:00 pm. Since recreational zone is regarded as a silence zone and therefore in principle, noise standards of silence zone could be applicable to it (i.e. 35 dB). The higher value in the morning because of school trips . Figure 9 shows the noise indices in recreational zones. Maximum NC and Lnp were 9.3dB between 10:00-11:00 am and 79.8 dBat the same period.

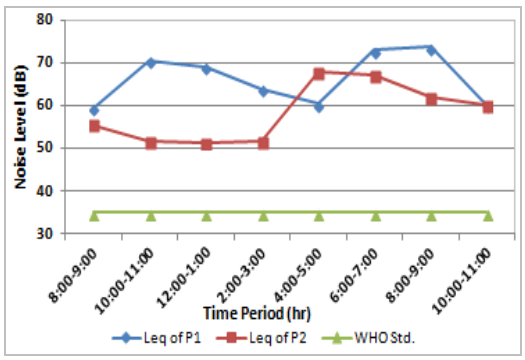

Figure 8. Average ambient noise levels in dB of recreational zones

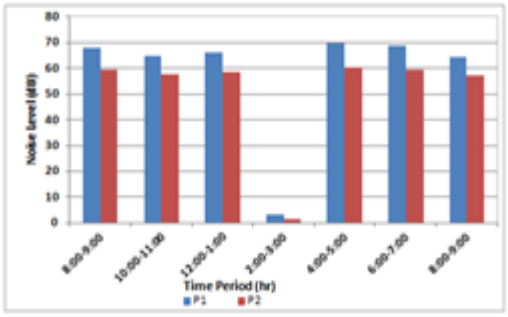

Figure 9. Average noise level indices in dB of recreational zones

Residential zone

Figure 10 and 11 show the noise level in the outdoor sites (residential zone). The data clearly indicates that all the average indices were found in the range of 62.4- 69.3 dB, which were well above the statutory limits of 55 dB prescribed by the World Health organization. One of the key noise pollution index (Leq) is also known as average sound level. It quantifies the noise environment as a single value of sound level for any desired duration. This descriptor correlates well with the effects of noise on people. Leq at different sampling zones varied from 75.2 dB to 55.8 dB. The highest Leq was recorded in Um-Alasafeer region (75.2 dB) between 8.00-9.00 am, while the lowest Leq recorded was 55.8 dB between 10.00-11.00 pm in the same region. The total average Leq = 65.2 dB which was not within the WHO limits. The highest value Lmax per hour measurement in Um-Alasafeer region was 75.5 dB at 8:00-9:00 am because of nearest this region from main highway street and passing of motorcycles and cars which causes the noise. The lowest value found in same region 56.3 dB at the time 10:00-11:00. Maximum NC and Lnp were 3.7dB between 10:00-11:00 pm in Al-Qishla region and 76.3 dB at the period8:00-9:00 am in Um-Alasafeer region

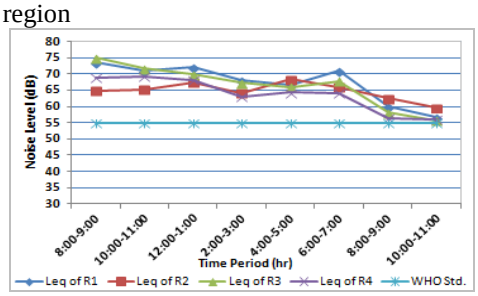

Figure 10. Average ambient noise levels in dB of risedential zones

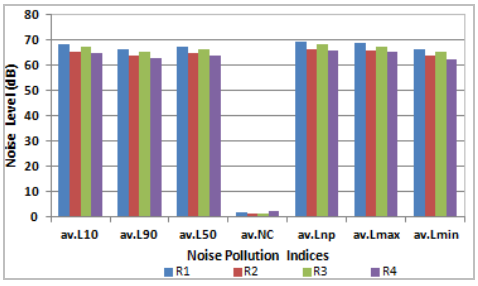

Figure 11. Average noise level indices in dB of residential zones

Traffic Areas

Noise pollution level for road traffic (Intersections and streets) are shown in Figure. 12, while the data of NC, Lnp and Leq is depicted in Table 3. It can be clearly seen that the corresponding values of L10, L50, Leq and Lnp were higher between the 8:00-9:00 am in university street 81dB, 78.1dB, 78.6 dB and 84.1 dB respectively. Highest L90 was 76.0dB at the time 10:00-11:00 am in university street. Noise standards of traffic areas could be applicable to it (i.e. 70 dB).

The higher value at the period time 8:00-9:00 am in university street because of presents many important institutions near from this street such as the birth and Children's Hospital and technical institute in addition to some crowded residential areas. Maximum NC was 8.9dB between 8:00-9:00 am in Al-Waqiaa street.

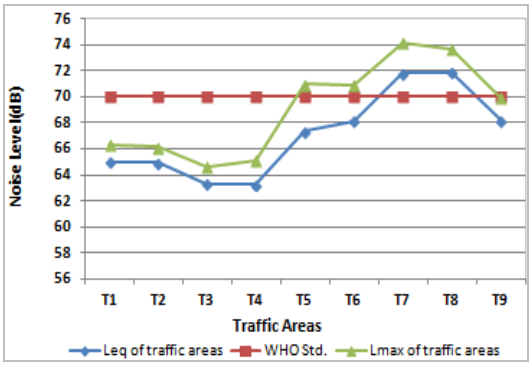

Figure 12. Average ambient noise levels in dB of traffic areas

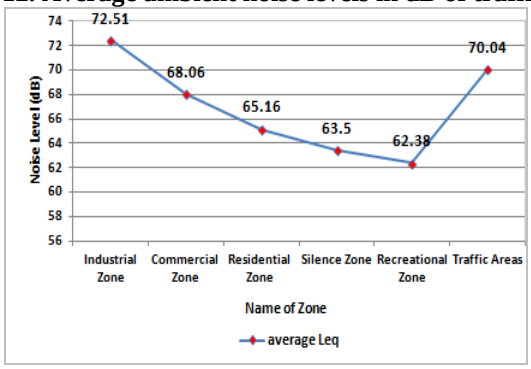

Figure 13. Average ambient noise levels in six zone of Al-samawah city

Figure 13 shows the average Leq, the sequence (in decreasing order) obtained was as follows: Industrial zone > Traffic Areas > Commercial zone > Residential Zone> Silence zone > Recreational zone. Noise pollution index (Lnp) is a combination of Noise Climate (NC) and Equivalent Continuous Noise (Leq) as stated in Eq. 3.

It gives an idea of noise pollution with fluctuations in noise level. It is considered as the best indicator of physiological and psychological impact of noise. Similar characteristic pattern of sequence was observed for average Lnp data as well, figure 14. Figure 15. shows the average NC, the sequence (in decreasing order) obtained was as follows: Industrial zone > Silence zone > Traffic Areas > Recreational zone> Commercial zone > Residential Zone.

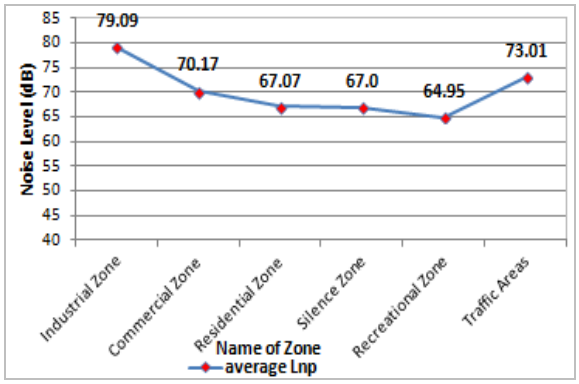

Figure 14. Average noise pollution level in six zone of Al-samawah city

Table 3. Data on noise pollution indices with reference to Noise Climate (NC) , Noise Pollution Level (Lnp) and equivalent noise level(Leq) for different zones of Al-Samawah city at different time interval

Average value								
Time	**8-9 am**	**10-11 am**	**12-1 pm**	**2-3 pm**	**4-5 pm**	**6-7 pm**	**8-9 pm**	**10-11 pm**
Silence Zone								
NC	4.1	3.1	1.6	4.4	4.1	4.1	3.7	3.1
Lnp	72.9	72.1	70.7	71.8	64.5	64.4	62.3	57.0
Leq	68.9	69.0	69.1	67.4	60.4	60.3	58.6	53.9
Commercial Zone								
NC	1.9	1.9	2.4	1.6	1.4	1.7	2.5	3.8
Lnp	73.3	75.7	73.4	74.5	77.9	61.7	59.5	59.7
Leq	74.0	75.1	72.4	69.9	76.9	63.3	57.7	55.1
Industrial Zone								
NC	5.0	10.9	11.2	10.7	5.9	2.0	3.8	3.2
Lnp	101.0	101.9	101.6	89.5	69.1	62.6	57.1	50.0
Leq	96.0	91.0	90.4	78.8	63.2	60.6	53.3	46.8
Recreational Zone								
NC	2.1	5.4	4.0	1.3	1.6	2.2	2.3	1.7
Lnp	59.6	66.5	64.2	59.0	65.9	72.4	70.2	61.8
Leq	57.5	61	60.3	57.8	64.3	70.0	67.8	60.1
Residential Zone								
NC	1.5	1.6	1.8	1.4	1.7	1.7	2.1	2.7
Lnp	72.2	70.9	71.2	67.1	68.1	69.0	61.3	59.7
Leq	70.7	69.3	69.4	65.7	66.4	67.3	59.2	57.0
Traffic Areas								
NC	3.5	3.0	3.3	3.1	2.9	2.8	4.7	1.7
Lnp	73.8	73.7	72.7	70.9	70.3	71.0	68.6	60.9
Leq	70.3	70.6	69.4	67.8	67.4	68.1	63.9	59.2

Table 4. Comparative account of observed Leq with Environmental Noise Standards(WHO)

Sr. No.	**Zone**	**Day time observed Leq (dB)**	**Day time Environmental Noise Standards (dB) (WHO)**			**Comments**
			For Industrial, Commercial, Traffic zone	**For Residential zone**	**Silence , Recreational Zone**	
Silence zone		63.5	---	---	35	Unacceptable
1	S1	63.0	---	---	35	Above limits
2	S2	64.0	---	---	35	Above limits
Commercial zone		68.1	70	---	---	Acceptable
3	C1	68.6	70	---	---	Below limit
4	C2	67.5	70	---	---	Below limit
Residential zone		65.2	---	55	---	Unacceptable
5	R1	67.4	---	55	---	Above limits
6	R2	64.8	---	55	---	Above limits
7	R3	66.5	---	55	---	Above limits
8	R4	63.8	---	55	---	Above limits
9 Industrial zone (I)		72.5	70	---	---	Unacceptable
Recreational zone		62.4	---	---	35	Unacceptable
10	P1	66.3	---	---	35	Above limits
11	P2	58.4	---	---	35	Above limits
Traffic areas		70.0	70	---	---	Acceptable
12	T1	65.0	70	---	---	Below limit
13	T2	65.0	70	---	---	Below limit
14	T3	63.3	70	---	---	Below limit
15	T4	63.3	70	---	---	Below limit
16	T5	67.4	70	---	---	Below limit
17	T6	68.2	70	---	---	Below limit
18	T7	71.8	70	---	---	Above limits
19	T8	71.9	70	---	---	Above limits
20	T9	68.2	70	---	---	Below limit

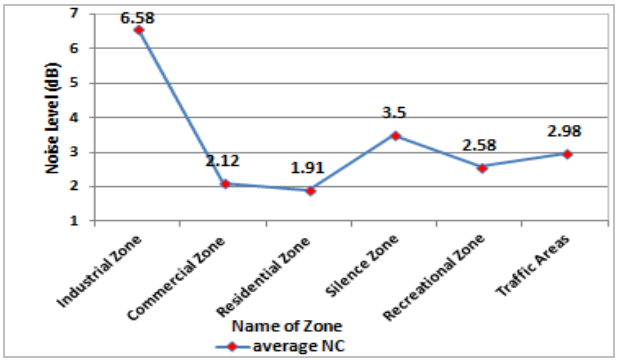

Figure 15. Average noise climate (NC) in six zone of Al-samawah city

The overall results on noise pollution in different zones of Al-Samawah city indicates that the noise pressure levels (Leq) were highly variable and significant at the different sampling zones/locations and were the manifestation of diverse man-made activities in these zones. It is well known that noise above certain level has the potentials to damage human health depending on its intensity, frequency and duration of exposure, as well as the individual's susceptibility. The disorders may be auditory or extra-auditory. Moura-de-Sousa and Cardoso (2002) noted that a noise up to 50 dB may be annoying, but one can be adapted to the situation [32]. A 55 dB noise causes a light stress, excitement, dependence and discomfort and a 65 dB noise causes a deep stress. At a 80 dB level of noise, the organism is likely to release biological morphine into the body, resulting in a feeling of pleasure that may lead to a type of dependence. At a 100 dB it is possible to have an irreversible hearing loss. The hearing effects of a noise that is intense enough are noise-induced permanent threshold shift, noise-induced temporary threshold shift, and acoustic trauma. Usually, these effects are accompanied by tinnitus [33].

Conclusions

The results of this study show that the level of noise pollution in Al-Samawah city exceeds the acceptable limits set by the WHO except commercial areas. Even in the residential areas and vulnerable institutions like schools and hospitals, noise is higher than the acceptable limit. This has serious implication on the general health and wellbeing of the inhabitants of the Al-Samawah city. It is also observed that noise level is closed related with the number of motor vehicles. Removal of old vehicles (especially motorbikes) along with obstacles of city roads that can influence noise pollution levels on streets. other measures include:

1. intensive plantation in open spaces, near residential and industrial places;
2. prohibition on the use of heavy vehicles in commercial and residential areas during day time or diversion of traffic to reduce noise pollution;
3. Removal industrial and commercial centers from the city limits to decrease sound pollution
4. Periodic noise monitoring on the roads;
5. noise impact assessment for any new or extra projects before granting the approval;
6. creating awareness among the masses through awareness programs, workshops, campaign, media, press, radio, TV, newspaper, etc.;
7. enforcement to ban the use of horns in silence zones as well as restriction of horns by vehicles when passing by residential areas.

Overall trend of the research papers show that noise pollution is becoming a severe problem in the urban environment, and Al-Samawah city is no exception to it. Furthermore, looking towards the current and future developmental trends of Al-Samawah city, it is the time for the local government to take precautionary actions to save people from the risk of noise pollution.

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