AMBIENT NOISE FLUCTUATIONS IN THE DIRE DAWA CITY, EASTERN ETHIOPIA

BELAY SITOTAW[*#], *E. MENGISTU*[*], *S. ZERIHUN*[*], *H. MAMO*[**]

[*]Department of Physics, Dire Dawa University, Ethiopia,
[#]e-mail: belaysitotaw@gmail.com
[**]Department of Biology, Dire Dawa University, Ethiopia

Abstract. The road traffic is one of the main sources of noise pollution in the urban area. The main purpose of this study was to measure the ambient noise fluctuation levels in five selected sites of Dire Dawa city. The study reports traffic noise fluctuations during the day and night since the city is an industrial corridor and it is used as a dry port for the country. The noise level was measured after the standard measure followed by standard calibrated devices. The variations of the equivalent noise levels were represented in figures and the total annoyance of the noise levels was calculated and shown in Table 1. The results revealed that the highest annoyance and the equivalent noise levels at Delchora hospitals were 83.15 dB and 85.20 dB respectively in the morning. However, the noise pollution level (L_{NP}) at Delchora Hospital during the morning is greater than in the afternoon. The minimum noise levels were measured in the residence of MA hotel 24.77 dB with the standard deviation of 0.10 in the morning time interval.

Key words: Equivalent noise, noise levels, decibels, L_{NP}, traffic noise.

INTRODUCTION

Noise is one of the most important factors in producing worsening of both well-being and quality of life of people in urban areas. Nowadays, traffic related noise is one of the major sources of noise in Dire Dawa city administration [23]. Noise produces a series of problems on physiological, psychological, behavioral changes [4, 31]. One of the types of noise which produces displeasure is traffic noise. It is the main environmental pollutant encountered in daily life of human being and which directly affects his health [24]. It is also a serious source of annoyance for people trying to rest and relax at home [2, 14, 26, 27], mainly when it interferes with sleep, contributing to the dilapidation of quality-of-life [1, 7, 8, 9, 17, 20].

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Noise pollution in urban environments comes from various sources, like sirens from road cross car, loud music from the bars or music shops, neighbors, car and home alarms, religious temples, horns, motorcycles, three wheel vehicles, trucks, passenger cars, buses, planes, trains, etc. [3, 15, 18, 22].

Dire Dawa shows that most noise pollutions are caused by lack of public awareness and the ignorance of people. This is why a lot of people in Dire Dawa are subjecting themselves to a loud noise. Homes, schools, offices, hospitals, commercial business centers, and other community buildings were routinely built close to the main roads without any adequate sound proofing.

The problem has been compounded by increasing in traffic volumes far beyond the expectations of our early urban planners. This alarming increase in the volume of traffic is actually inversely related to the degradation of the environment [16]. The recent survey that was done in the city by [23] shows that traffic related noise problems increase in the alarming rate in the city. Though, this work did not show the ambient noise fluctuation of the city noise level. Therefore, the aim of the present study is carried out to analyze the ambient noise fluctuations among the roadside dwellers, employees working in roadside offices, organizations, etc., due to road traffic noise pollution and to compute annoyance level of noise pollution in Dire Dawa City Administration in the selected site.

LITERATURE REVIEW

Noise is a major agent of air, atmospheric, and environmental pollution [5]. As WHO reveals, noise is a dangerous agent, which affects human health and the environment [18, 29, 30]. Today, noise pollution is no longer restricted to industrial environments but it affects the residence and working areas. It is a daily reality both in developed and underdeveloped countries [28]. It is a global issue as climate problem which has unenthusiastic health effects of environmental noise [22]. Traffic noise can cause various health problems such as sleep disturbance, high blood pressure, and psycho-physiological symptoms [21].

Recent researches clearly reveal that road traffic noise has been proven to have a predominant source of annoyance; no other single noise has comparable importance. Here, there are a large number of three wheel vehicles and auto-motives in comparison with other machines. The research, done by different scholars in the world shows that traffic noise is one of the major problems. It was done by [23] in Dire Dawa and shows that traffic noise level has reached the highest level.

Road surfaces influence the generation of noise by tyre/road interaction and the propagation of noise from the vehicle engine and transmission system [25]. The noise produced by the tyres depends on the road surface and the type of tyre. The relevant factors for noise emission are the texture of the surface, the pattern and the degree of porosity of the surface structure, temperature, pressure, and the speed

[10, 11, 13, 19]. The most important factor is the roughness of the road surface (texture) and the tread of the tyre. Everyone is familiar with the effects of driving on paving stones, cement block paving or cobblestones.

MATERIAL AND METHODS

The study was conducted at Dire Dawa city located between latitude 9°27' and 9°49' North and longitude 41°38' and 42°19' East, on an average altitude of 1,221 m. It is the second largest city and it is located in the eastern part of Ethiopia. The city has witnessed enormous growth in the size of built-up areas, number of immigrants from neighboring country and from different regions of the country itself, transportation, the newly establish industry zones and commercial activities.

In carrying out the noise level measurements, five locations from the nine Kebeles were carefully selected for the comparative studies. The measurement of the sound level was carried out using an Az8928 used to measure the sound intensity which ranges from 40 to 130 dB sound levels [23]. The device was calibrated and recording were taken at this standard level. The instrument is very suitable for environmental noise survey. It was mounted at a height of 1 m above the ground and 1 m away from the edge of the road for all the locations for consistency of measurement with the antenna pointing to the sound source.

The instrument was used to measure the noise level (L). The equivalent noise level can be computed using Eq (1). The computation was carried out for the five locations at two different times of the day: 9.00–13.00 a.m. and 18.00–22.00 p.m. The instrument was set to measure sound intensity level every one minute at one location. This is because the instrument faithfully follows all the fluctuations and, at the end of the measurement, the equivalent noise levels, in decibels (dB), using Equation (1) were calculated [12].

The computed equivalent noise levels, L_{eq}, were used as input data in the calculation of the day and the night noise level:

$$L_{\text{eq}} = 10\log\left[\frac{1}{n}\sum\nolimits_{i=1}^{n}\left(10^{L_i/10}\right)\right], \tag{1}$$

where L_{eq} is the equivalent noise level during measurements, L_i is the intensity sound level measured at the i-th time interval.

RESULTS AND DISCUSSION

The traffic noise was measured at the spots along the main road line. Noise pollution was assessed in five selected sites of the city to observe the noise fluctuations and the noise annoyance problem in the administration.

Figure 1 shows the equivalent noise fluctuation on February 10, 2017 in the morning time from 9:00 to 13:00 a.m. The result shows that the equivalent noise fluctuates with time which depends on the number of trucks arriving at the MA hotel. The highest fluctuation values are due to the traffic noise at the beginning of the recording. At 10:00 a.m., the equivalent noise fluctuation is minimum, due to the number of trucks arriving at this time when the speed of the vehicles is slow enough. The fluctuation of the noise reached a peak at 12:30 p.m. The possible reason for this is that the number of trucks moving along the road is large. At the same place, we have recorded the equivalent noise fluctuation in the afternoon to midnight, which is shown in Figure 2. The result shows that the minimum noise fluctuations of the equivalent noise appeared three times at different times. There were higher fluctuations of equivalent noise in the morning than in the afternoon until the midnight.

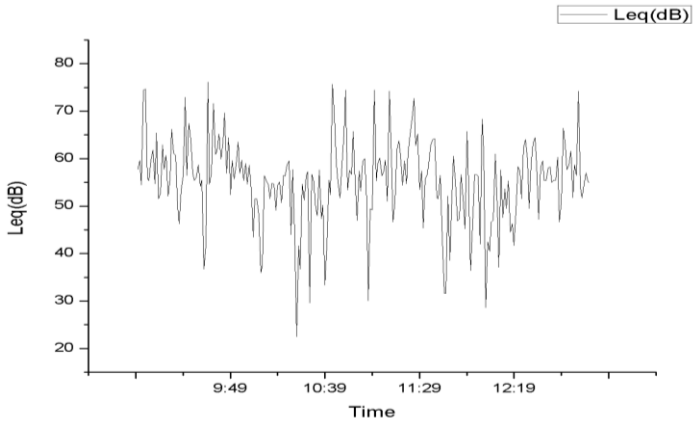

Fig. 1. Morning variation of the equivalent noise fluctuations with time on February 10, 2017 near to MA Hotel.

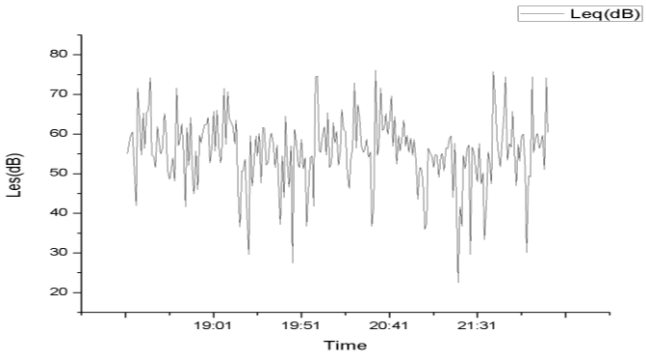

Fig. 2. The afternoon to midnight variations of the equivalent noise flctuations at MA Hotel on February 11, 2017.

The second site of the recording was the roadside to Delchora Hospital, a crossroad around Delchora. In addition, there is the main road which connects the city with the neighbouring regions. The observed fluctuations both in the morning and in the afternoon have the same pattern at the beginning of recording. The equivalent noise fluctuations, shown in Fig. 3, are above 60 dB at noon, whereas, in the night are shown in Figure 4. When the time is beyond 0:30 p.m., the fluctuation of ambient noise is high. Between 0:30 and 1:00 p.m., there was a high fluctuation of the equivalent noise levels. This was one of the periods when the traffic reaches the peak value. It is the lunch-time when the movement of people across this line is the highest one. The main line of the city road was crowded by different vehicles. Even after 1:00 p.m., the noise fluctuation has reached a minimum of 20 dB.

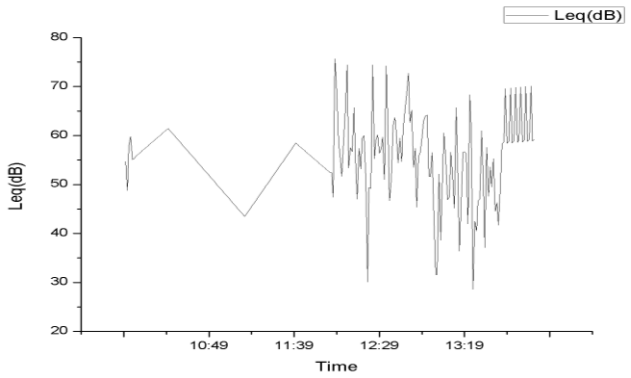

Fig. 3. Variations of the equivalent noise levels near to Delchora Hospitals in the morning on Feburary 13, 2017.

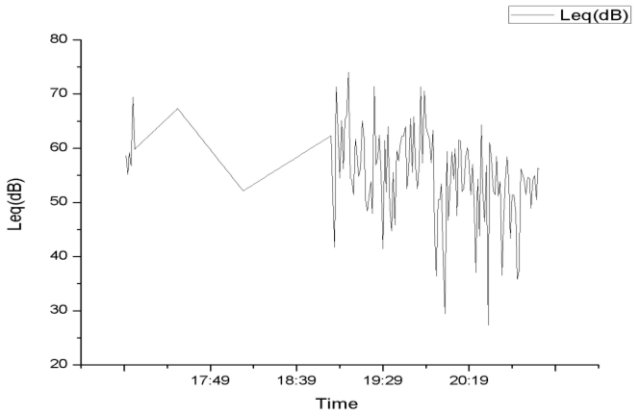

Fig. 4. Variations of the average noise levels near Delchora Hospital in the afternoon on Feburary 14, 2017.

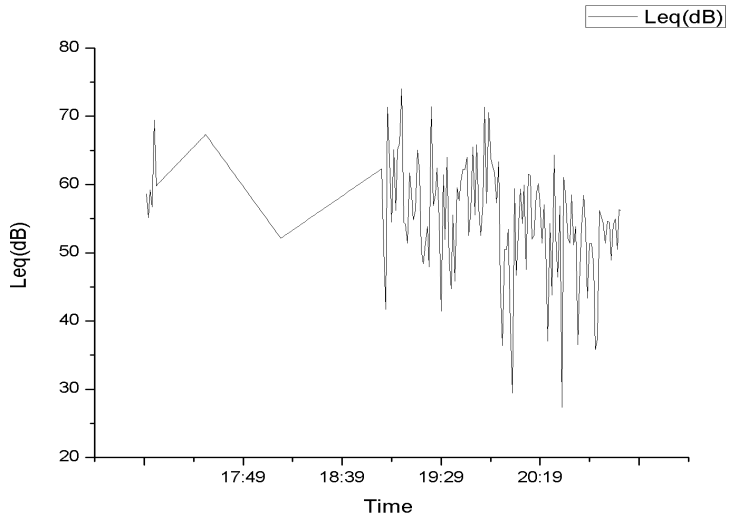

Fig. 5. Variations of the equivalent noise levels in Medhyanalem school in the afternoon on February 15, 2017.

As we can see from Figure 5, the noise fluctuations were observed. High fluctuations were observed from 19:00 to 21:00 p.m. In these time intervals, the noise fluctuations reach 75 dB in some cases, which is the upper limit of the noise levels set by the Environmental Pollution Control Proclamation No. 300/2002, prohibiting any person from polluting the environment by violating the pertinent standard.

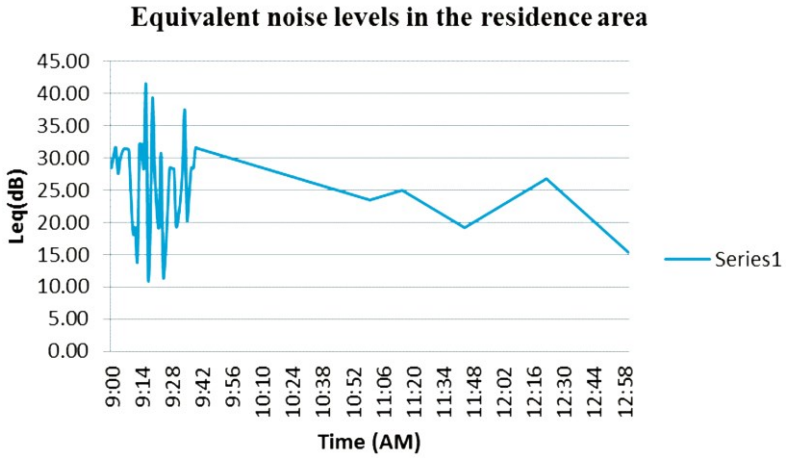

Fig. 6. Variations of the equivalent noise level in one of the residence areas of Gende Lomi on Feburary 16, 2017.

As we can see from Fig. 6, there were high fluctuations of the equivalent noise only in the morning from 9:00 a.m. to 1:00 p.m. whereas, on this time onward, the equivalent noise fluctuations slow down and rise up and again fall down in a non uniform pattern. The most probable reason for such flctuations is the smaller number of vehicles on the road than during the earlier time.

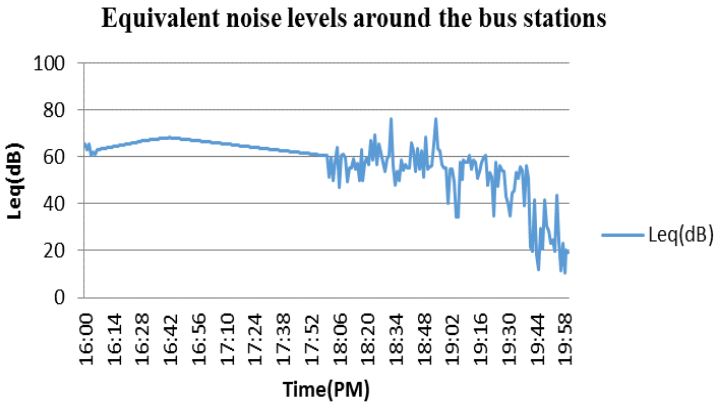

Fig. 7. Variations of the equivalent noises level around the bus stations in the afternoon on Feburary 18, 2017.

Figure 7 shows that the equivalent noise fluctuations in the first two afternoon hours did not show any significant change. However, there were high fluctuations from 18:00 to 20:00 p.m. This was due to the volume of vehicles in the road. At the midnight, the movement of the vehicles found around the bus station was less, there was not a high fluctuation on the day time, but there were some other sources of noise, like dogs and music from night clubs from the other corners of the city.

As we can see from Figs. 1 to 7 the public road network is insufficient in comparison to the rate of increase in traffic volume. The noise fluctuations in all selected sites were not uniform. This is due to the random volume of traffic vehicles and the types of road. In addition, the improper modernization and maintenance of the roads (high proportion of asphalted roads, with road cobblestone or gravel or with degraded asphalt), narrowness of the roads and inadequate traffic management further aggravate the situation in the city.

The total noise annoyance can be calculated from the equivalent noise level measured during the observation and is given by [12]:

$$L_{NP} = L_{eq} \cdot 2.56 \cdot \delta, \tag{2}$$

where L_{NP} is the total noise pollution, L_{eq} is the equivalent noise level, and δ is the standard deviation.

The average intensity level of noise in this particular place with the average annoyance noise level is shown in Table 1. Results of five specific cities of the study area were taken to account the annoyance level of noise. Table 1 shows the equivalent noise, total annoyance level, and the standard deviation of noise in five selected sites of the city administration. The result shows that the annoyance level of noise around Delchora Hospital is the highest which gives an uncomfortable feeling to the people around that area. As a result of this, the efficiency of people can decrease in their daily jobs.

The peak equivalent noise level was computed as 87.56 during 5:00–9:00 p.m. and 86.10 dB during 9:00 a.m. to 1:00 p.m. at the bus station. All these computed values exceed the government regulations [6]. Still, there was a significant amount of equivalent noise levels computed in MA hotel, Delchora hospital and Medhaniyalem School. Overall the equivalent noise level at the nearest residence, Gende Lomi located far away from the main road was 48.78 dB in the morning and 49.99 dB in the afternoon.

The maximum amount of L_{PN} in the area of Delchora was 83.15 dB in the morning and 81.90 dB in the afternoon in the bus station. The least L_{PN} was 24.77 dB found around MA hotel in the morning and 26.82 dB found in the afternoon around Delchora hospital.

Generally, we can see that the recorded noise values were high as compared to the standard values set by the Environmental Pollution Control Proclamation No. 300/2002 [6] in the service sector area but it is less than the standard value in the residence area in Gende Lomi. In Gende Lomi, the volume of traffic flow is less than in the other sites. Bus station is a mixed area of business, office, and residence site in the city. The annoyance level of the noise was higher at day time than during the night. The computed values are greater than the value set by the government.

Table 1

The equivalent noise levels, the average annoyance noise level of sound, and the standard deviation in the selected sites of the city

Place	Time interval	Annoyance level noise pollution (L_{PN}) (dB)	Equivalent noise (L_{eq})(dB)	Standard deviation
MA Hotel	1	24.77	57.70	0.10
	2	71.10	87.06	0.32
Medhaniyalem school	1	54.91	74.20	0.25
	2	66.29	84.97	0.30
Delchora hospital	1	83.15	85.20	0.38
	2	26.82	85.10	0.12
Gende Lomi	1	48.78	51.02	0.37
	2	49.99	56.12	0.35
Bus station	1	62.53	86.20	0.28
	2	81.90	87.56	0.37

[1]Morning time (9:00 a.m. to 1:00 p.m.); [2]afternoon time (5:00 to 9:00 p.m.).

CONCLUSIONS

This study was carried out to evaluate the ambient environmental noise pollution in the city of Dire Dawa due to traffic. We have measured the intensity levels during the passage of vehicles with and without their horn blowing on the main road. Based on the measurement results, we have calculated the equivalent noise levels. Lastly, we assessed the degree of annoyance level due to noise generated by vehicles around the main road line. Very high environmental noise levels due to traffic or vehicles were observed during the study possibly causing disturbance and even some health problems. Based on the study findings it can be inferred that there is an urgent need to set up a noise standard in the city in order to avoid the noise pollution. The findings showed that traffic noise is one of the most sources of noise in the city, with a very high ambient fluctuation. Moreover, our results suggest that it is essential to make a major step towards revising the environmental protection protocol set by the Federal Government. Thus, it needs for an immediate intervention of the management and the system designers to make and implement effective plans to reduce the adverse effects of noise in order to ensure health, safety and to enhance efficiency and comfort of the area residents.

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