

Comparative Study on the Noise Level Change in Alexandria City, Egypt

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Abstract— Alexandria is considered the second biggest urban settlement in Egypt after great Cairo. The total area of Alexandria is about 2818.77 km² which represents 22.5 % of Egypt's area. In the last years Alexandria has faced many changes in its urban planning such as roads extends and bridges' construction. The city also has experienced a rapid increase in the construction rate and economic development due to the increase in the number of populations. Many significant changes in the city's land use have been observed. In order to track how these land use changes', affect the noise levels in Alexandria city; a study will be done through this research to compare the noise level in present time and between Zekry F. Ghatass's study about the assessment and analysis of traffic noise pollution in Alexandria city, Egypt in 2008. And the results show that the L_{DEN} that was recorded in 2008 was higher than the calculated permissible noise level with about 21.4 dB through the last 10 years and these high noise levels must be taken in consideration due to its bad impact on human health.

Index Terms— Alexandria, Comparative study, Egypt, Pollution, Landuse, Noise levels, Traffic density, Urban planning.

1 INTRODUCTION

One of the major environmental crises facing most of countries all around the world is the environmental pollution. The massive growth in the cities' urban scale and the industrial and technological development led to big amount of harmful wastes in the environment. Environmental pollution and its consequences also affect the quality of human life. "Environmental noise" is a term to describe noise pollution which is the propagation of noise with harmful impact on the daily activities [1]. In addition to that noise pollution can be considered as a form and level of environmental sound that is generally considered likely to annoy, distract or even harm people. Noise pollution effects have different impacts on human's mental and physical health and disturbance of daily activities and that effects can cause temporary or permanent hearing loss, ranging from slight impairment to nearly total deafness, headache and the consequences may reach to cause heart attacks [2]. While short-term effects, include interference with speech communication and the perception of other auditory signals, disturbance of sleep and relaxation, annoyance, interference with an individual's ability to perform complicated tasks, and general diminution of the quality of life [3].

The noise produced from traffic flow is considered one of the major sources of noise pollution in cities. Traffic roads and means of transportation such as airplanes, buses, trains, heavy trucks and motor-cycles include vehicles noises which produced from engines, exhausted pipes, horns, gearboxes, breaks and tire road friction [4]. Poor urban planning and land use changes could make a main factor that increases the noise pollution level in cities. Thus, this research will focus on how the urban planning and land use changes effect on the noise levels in the city.

2 LITERATURE REVIEW

Frequency and sound pressure level are main properties of sound. A sound with a high frequency is a high-pitched and

a sound with a low frequency is a low-pitched and sound that is perceptible by humans has frequencies between 20 Hz and 20,000 Hz [5]. Human can perceive a range of sound pressure from very soft sound with 0 dB which represents the faintest sound, while the sound which is audible to a normal ear to range from 70-85 dB and very high sound 120 dB and it is called threshold of pain level at this level sound pressure could cause the damage of human ear as presented in figure 1 [6].

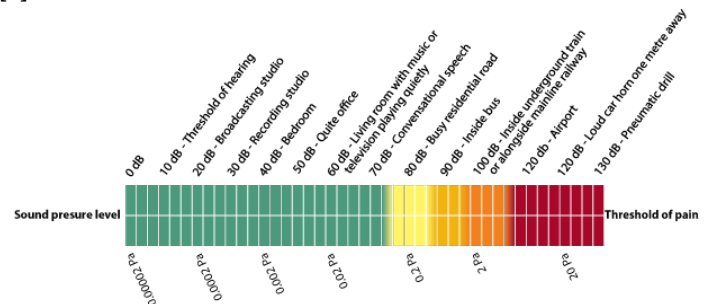


Fig. 1. Indicates the relation between sound pressure level (dB) and the threshold of pain. As the dB increase from green color to red color the level of pain increase and the harmful influence of noise increase [7].

Noise is originated from human activities, especially urbanization and the development of transport systems. Though the urban population is much more affected by such pollution, small towns/villages along side roads or industrial areas are also affected by this pollution [8].

The source of most outdoor noise worldwide is transportation systems, including roads, flyways, and rail traffic [1]. Poor urban planning give rise to noise pollution, since side-by-side industrial and residential buildings can result in noise pollution in the residential area. People living in urban city complained about the noise from automobile traffic, overhead

airplanes and helicopters, leaf blowers, pneumatic drills as well.

Other sources of indoor and outdoor noise pollution are generators, car alarms, emergency service sirens, office equipment, factory machinery, grounds keeping equipment, barking dogs, appliances, power tools, lighting hum, audio entertainment systems, loudspeakers, and neighborhood sounds. Large urban areas are being inundated by unwanted sounds [1], [9].

The sources in general may be stationary or mobile. The example of stationary sources is such as when use of loudspeakers on various occasions like festivals, elections, worship in temples, mosques and during advertisements, mining operations, use of bulldozers, drillers and dynamites to break rocks, household gadgets like vacuum cleaner, TV, radio, stereo, grinder, mixer. In the other hand, mobile sources can be classified in transportation / traffic noise (road traffic or highway noise), industrial noise, and noise from construction work and also neighborhood noise [9].

As a conclusion to previous studies noise pollution sources are classified in to seven types as following: **Industrial Sources** which produce noise ranged from 100 to 130 dB, **Transport Vehicles** which produce noise ranged from 85 to 120 dB, **Household** which produce noise ranged from 70 to 90 dB, **Public Address System** which produce noise ranged from 85 to 110 dB, **Agricultural Machines** which produce noise ranged from 100 to 130 dB, **Defense Equipment** which produce noise ranged from 100 to 140 and **Miscellaneous Sources** which produce noise ranged from 100 to 130 dB [10].

Through the last years noise pollution has raised to become one of the main environmental issues in Egypt [11]. The noise levels in the Egyptian cities have exceeded the acceptable limits locally and internationally. Egypt is ranked in the third place of the worst ten cities for noise pollution with is capital Cairo after Guangzhou, China that comes in the first place and Delhi, India in the second place [12], [13]. In 1992, the Ministry of State for Environmental Affair was charged to institute the Egyptian Environmental number 4 law in 1994 and the ministry was responsible for its execution regulation. The law 4/1994 identified the maximum permissible noise limits for different land uses as shown in table 1, and then in 2009 the law was updated [14].

TABLE 1

EGYPTIAN NOISE STANDARDS AND POLICY ON THE MAXIMUM PERMISSIBLE LIMIT FOR NOISE INTENSITY LEQ (dB) IN DIFFERENT LAND USE AREAS ACCORDING TO EGYPTIAN ENVIRONMENTAL LAW NO. 4/1994 [14].

Type of area	Permissible limit for noise intensity (dB)		
	Day (7 am - 6 pm)	Evening (6-10 pm)	Night (10 pm - 7 am)
Rural residential areas, hospitals and gardens	45	40	35
Residential suburbs with low traffic	50	45	40
City residential areas	55	50	45
Residential areas with commercial es-	60	55	50

Establishments			
Commercial, administrative and downtown areas.	65	60	55
Industrial areas (heavy industry)	70	65	60

Traffic roads and means of transportations is the prime source of noise pollution. 60% of noise is caused by traffic [15]. Also population growth, associated activities and lack of city urban planning are the major causes of high noise levels in most of cities and capitals [13], [16]. Thus, this research will focus on comparing between the noise levels in the Egyptian streets through ten years and how the change in the urban planning and land use changes' affected these levels.

3 METHODOLOGY

The study of noise level in Alexandria is held on Elgeish road as one of the main roadways in Alexandria. This roadway connects the city from east to west passing through the city waterfront. Due to the large number of citizens and big number of vehicles in the city, there is always high traffic rate on this road which leads to high noise levels especially after changes in land-use between years 2008 to 2018.

Five site locations are selected along Elgeish roadway on the northern side of the road. The selected locations are Stanley, Sidi Gaber, Sporting, Camp Cesar and El Shatby. This side of the roadway that is selected for the study has the biggest changes in the land use and urban layout through the past years and most of the citizens' activities are done on this side of the road as shown in figure 2.

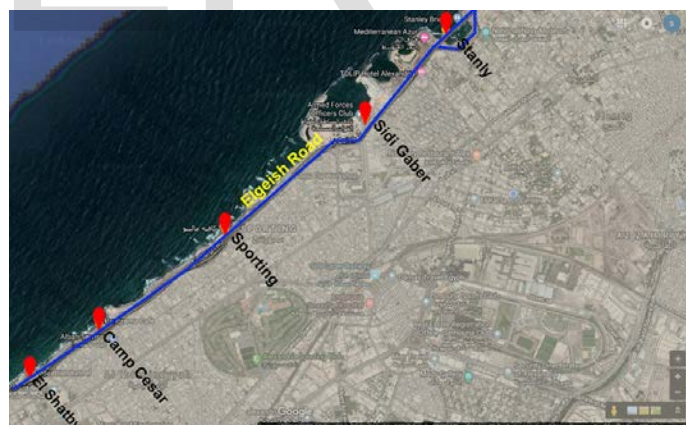


Fig. 2. Shows the five selected locations along Elgeish roadway in Alexandria city, Egypt [Google Maps and modified by researcher, 2018].

The noise level measurements were carried out during October 2018 for five selected locations along Elgeish Street in Alexandria City on working days (Monday to Thursday) as they are crowded week days, readings were compared to the noise level measurements that was presented in Zekry's study in 2008 [17].

The measurements timing is selected according to the International Organization for Standardization (ISO) [18], [19], [20] and the Egyptian Environmental Law No. 4/1994 where

each time of the day has its permissible noise level [14]. The permissible limit for noise pressure at day is 65 dB, at evening is 60 dB while at night is 55 dB at the commercial, administrative and downtown areas and streets.

The selected measuring interval is 2 hours, the readings are taken every 15 minutes using UT 353 digital sound meter device, giving 8 readings at each interval for each time of the day at each selected station. The mean equivalent sound pressure level (Leq), the maximum sound pressure level (Lmax) and the minimum sound pressure level (Lmin) in (dB) is calculated for each time of the day at the selected location.

Then sound pressure index (LDEN) is calculated for the mean, maximum and minimum using the following equation for each station: $L_{DEN} = 10 \log 1/24 (11*10^{LD} + 4*10^{LE+5} + 9*10^{LN+10})^{1/10}$ (dB) [17].

In this research, UT 353 digital sound meter device is used to measure the noise levels at the selected stations. It covers Functions Range Resolution Accuracy Noise (A Weighting) range from 30 dB till 130 dB with precision ±1.5 dB.

4 RESULTS

The minimum, maximum and the mean equivalent value of noise levels at all selected locations were calculated and represented in tables 1, 2, 3, 4 and 5 in comparison with the values of noise levels that were recorded in Zekry's study in 2008 [17].

TABLE 2

PRESENTS THE COMPARISON BETWEEN MINIMUM, MAXIMUM AND MEAN EQUIVALENT VALUE NOISE LEVELS AT STANLY LOCATION AT PRESENT TIME [RESEARCHER, 2018] AND ZEKRY'S STUDY IN 2008 [17].

Location	Date	Lmin (dB)	Lmax (dB)	Leq (dB)
Stanly Location	In 2008	63.3	100	85.5
	In 2018	64.2	102.5	87.6

TABLE 3

PRESENTS THE COMPARISON BETWEEN MINIMUM, MAXIMUM AND MEAN EQUIVALENT VALUE NOISE LEVELS AT SIDI GABER LOCATION AT PRESENT TIME [RESEARCHER, 2018] AND ZEKRY'S STUDY IN 2008 [17].

Location	Date	Lmin (dB)	Lmax (dB)	Leq (dB)
Sidi Gaber Location	In 2008	60.2	90.4	80.3
	In 2018	60.1	96.8	83.4

TABLE 4

PRESENTS THE COMPARISON BETWEEN MINIMUM, MAXIMUM AND MEAN EQUIVALENT VALUE NOISE LEVELS AT SPORTING LOCATION AT PRESENT TIME [RESEARCHER, 2018] AND ZEKRY'S STUDY IN 2008 [17].

Location	Date	Lmin (dB)	Lmax (dB)	Leq (dB)
Sporting Location	In 2008	59.7	92.6	78.4
	In 2018	57.9	87.1	80.6

TABLE 5

PRESENTS THE COMPARISON BETWEEN MINIMUM, MAXIMUM AND MEAN EQUIVALENT VALUE NOISE LEVELS AT CAMP CESAR LOCATION AT PRESENT TIME [RESEARCHER, 2018] AND ZEKRY'S STUDY IN 2008 [17].

Location	Date	Lmin (dB)	Lmax (dB)	Leq (dB)
Camp Cesar Location	In 2008	65.4	98.3	77.6
	In 2018	55.3	93.5	78.2

TABLE 6

PRESENTS THE COMPARISON BETWEEN MINIMUM, MAXIMUM AND MEAN EQUIVALENT VALUE NOISE LEVELS AT EL SHATBY LOCATION AT PRESENT TIME [RESEARCHER, 2018] AND ZEKRY'S STUDY IN 2008 [17].

Location	Date	Lmin (dB)	Lmax (dB)	Leq (dB)
El Shaby Location	In 2008	65.2	94.8	82.5
	In 2018	56.2	101.2	93.6

The results show that the maximum noise level in the present time [Researcher, 2018] was recorded at Stanly with 102.5 dB and it was also the highest recorded noise level in 2008 [17] with 100 dB, while the minimum noise level was recorded at Camp Cesar location at present time with 55.3 dB while it was at Sporting location in 2008 with noise level of 59.7 dB. Also it was noticed that all mean equivalent noise levels at all locations was higher than any of the permissible levels allowed by the Egyptian Environmental law and ISO standards at any of the day time intervals.

TABLE 7

PRESENTS THE PERMISSIBLE LIMIT FOR NOISE LEVELS ALLOWED BY ISO [18] [19] [20] AND THE EGYPTIAN ENVIRONMENTAL LAW NO. 4/1994 [14] AND THE EQUIVALENT MEAN LEQ AT PRESENT [RESEARCHER, 2018] AND ZEKRY'S STUDY IN 2008 [17] THROUGH THE THREE DAY TIME INTERVALS

Location	Day timing according to ISO and Egyptian law	Permissible limit of noise pressure (dB)	In 2008	In 2018
Elgeish Road	Day (7am-6 pm)	65	83.7	89.8
	Evening (6pm-10pm)	60	82.2	85.4
	Night (10pm-7am)	55	62.7	76.2

The LDEN for the permissible limit of noise was calculated using equation $L_{DEN} = 10 \log 1/24 (11*10^{LD} + 4*10^{LE+5} + 9*10^{LN+10})^{1/10}$ (dB) so the LDEN index will be calculated for Elgeish road to compare between present levels and the readings recorded in 2008 to the permissible limit for noise levels allowed by ISO [18] [19] [20] and the Egyptian Environmental Law No. 4/1994 [14].

TABLE 8

PRESENTS THE PERMISSIBLE LIMIT FOR NOISE LEVELS ALLOWED BY ISO [18] [19] [20] AND THE EGYPTIAN ENVIRONMENTAL LAW NO. 4/1994 [14] AND THE EQUIVALENT MEAN LEQ AT PRESENT [RESEARCHER, 2018] AND ZEKRY'S STUDY IN 2008 [17] THROUGH THE THREE DAY TIME INTERVALS

Location	Day timing according to ISO and Egyptian law	Permissible limit of noise pressure (dB)	Calculated Permissible Equivalent L_{DEN} (dB)	In 2008	In 2018
Elgeish Road	Day (7am-6 pm)	65	52.6	83.7	89.8
	Evening (6pm-10pm)	60		82.2	85.4
	Night (10pm-7am)	55		62.7	76.2

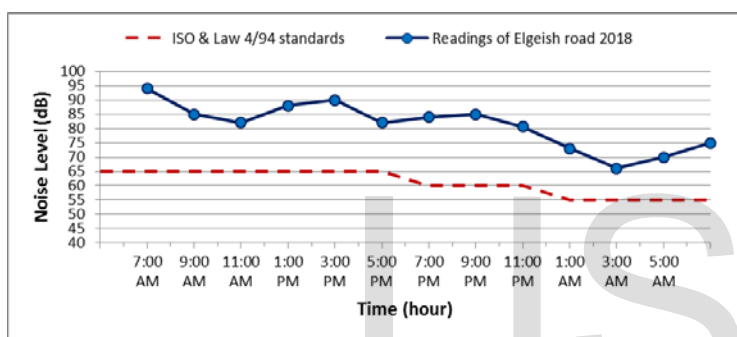


Fig. 3. Presents the variation of noise levels at Elgiesh road along the different intervals of the day at present time compared to the standard permissible limit for noise levels according to ISO standards and Egyptian Environmental law 4/94 [Researcher, 2018].

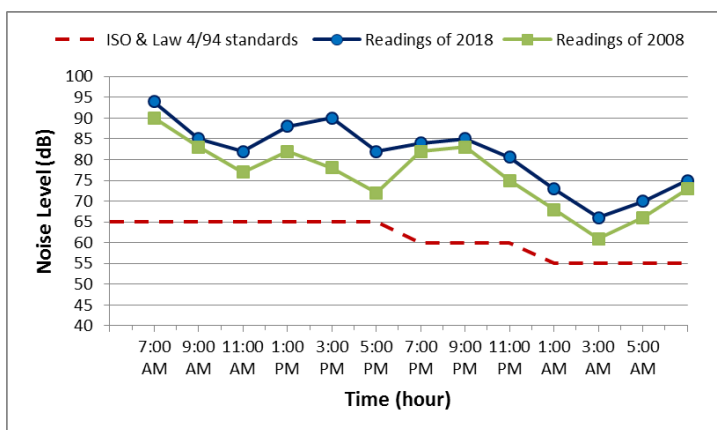


Fig. 4. Presents a comparison between the variation of noise levels at Elgiesh road in the present time 2018 and Zekry's study in 2008 [17] along with the different intervals of the day at present time compared to the standard permissible limit for noise levels according to ISO standards and Egyptian Environmental law 4/94 [Researcher, 2018].

5 DISCUSSION

On measuring and assessing the noise levels at five stations selected locations along Elgeish road which is one of the

major axis in Alexandria City, Egypt, using digital sound meter device and the selected measuring intervals according to International Organization for Standardization (ISO) [18] [19] [20] and the Egyptian Environmental Law No. 4/1994 [14] The results show that the noise levels in all selected locations exceeded the permissible limit for noise levels allowed by the Environmental Egyptian Law No. 4/1994 in the present time and also in Zekry's study in 2008 [17].

The results show that the L_{DEN} that was recorded in 2008 [17] was higher than the calculated permissible noise level with about 21.4 db, while the present noise level L_{DEN} that was recorded through this research was higher than the calculated permissible noise level with about 24.8 db, and this means that the noise levels is increased by about 7% through the last ten years due to the massive change that happened in the land use and urban planning of the Alexandria city, Egypt in only small section from one of the main roadways.

These high noise levels have harmful and damaging effect on human physiological and mental health. Thus, it is a big environmental problem that must be taken in consideration during designing, planning and expansions of cities.

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