Available online at www.garmian.edu.krd

Passer Journal of Basic and Applied Sciences

Passer 7 (Issue 2) (2025) 641-649

Original Article

An analysis of Noise Pollution in Residential Areas of Kalar, Kurdistan-Iraq

Saryaz Salih Hussein* [1]

[1] *Department of Geographic, College of Education, University of Garmian, Kalar 46021, Kurdistan Region, Iraq*

Received 29 December 2024; revised 08 Marcj 2025;
accepted 09 May 2025; available online 16 July 2025

DOI: 10.24271/PSR.2025.496644.1878

ABSTRACT

Noise pollution is a persistent environmental issue that affects both public health and overall quality of life. In urban areas like Kalar City, elevated noise levels can disrupt daily activities, cause stress, and contribute to long-term health complications. This study aims to assess the environmental noise pollution in Kalar using an SL720 sound level meter to quantify sound intensity and determine its broader impact. Measurements were conducted at various times throughout July and August—specifically at 7:00–11:00 a.m., 12:00–2:00 p.m., 5:00–6:00 p.m., and 8:00–11:00 p.m.—to capture variations in noise exposure during different periods of the day. The findings indicate that Kalar City's daytime mean equivalent noise level varies from 43 dBA to 69 dBA. Notably, the nighttime mean equivalent noise level is almost as high as the daytime levels, ranging from 56 dBA to 83 dBA. This suggests that noise pollution remains a constant concern throughout the day and night, potentially affecting residents' sleep quality and overall well-being. Further analysis of the data reveals that the Central Business District of Kalar records the highest day-night noise level at 89 dBA, while the lowest level was observed at a different location, measuring 62 dBA. The study also determined that the city's overall average day-night noise level stands at 72.6 dBA, reflecting a considerable degree of noise exposure across different urban zones.Based on these findings, targeted measures, such as urban planning adjustments, noise barriers, and stricter regulations on industrial and transportation-related noise, could help reduce excessive sound exposure. Increasing public awareness and encouraging community-driven initiatives may also play a vital role in fostering a quieter and healthier environment. By addressing these concerns, urban residents can experience improved living conditions and lower risks associated with prolonged noise pollution.

Keywords: Sound Pressure Level (SPL), pollution, Environmental noise, Decibel, Kalar.

1 Introduction

Noise pollution refers to unwanted or excessive sound that disrupts the natural acoustic environment, leading to a range of health and socio-economic issues. As an environmental contaminant, noise pollution has grown rapidly due to advancements in commercial, industrial, and social activities. Often considered an unintended consequence of urbanization, it increasingly interferes with essential daily activities such as studying, working, recreation, and rest[1]. One of the primary drivers of this escalation is the swift expansion of cities, which introduces more sources of disruptive noise[2].

According to the World Health Organization (WHO), noise pollution is regarded as the third most hazardous environmental factor in major cities, ranking behind air and water pollution. In many urban areas worldwide, it has emerged as a pressing issue of both national and global concern[3,4]. Beyond its immediate nuisance, excessive noise is known to have significant physiological and psychological effects on urban residents. Consequently, noise pollution is now considered a crucial determinant of urban quality of life, influencing both social and economic well-being[5,6].

A fundamental concept in the study of sound pollution is sound pressure, which encompasses all aspects of sound production, transmission, and reception[7]. The sound pressure level is influenced by both the power output of a noise source and the conditions of the surrounding environment. The human ear, capable of processing a wide range of auditory inputs, can differentiate between subtle changes in sound pressure levels. However, when sound becomes intrusive—interfering with reading, working, sleeping, or relaxation—it is classified as a disturbance rather than a neutral environmental factor[1].

To quantify noise levels, scientists use the decibel (dB), a logarithmic scale that measures sound intensity. The lowest detectable sound level for the human ear is 0 dB, also known as the threshold of hearing, while the threshold of pain is approximately 120 dB, beyond which sound can cause immediate discomfort or damage. A 3 dB change is barely noticeable to most

* Corresponding author
E-mail address sareaz.salih@garmian.edu.krd (Instructor).
Peer-reviewed under the responsibility of the University of Garmian.

individuals, but an increase of 10 dB is perceived as a doubling of the sound's volume[8].In environmental noise assessment, the A-weighted scale (dBA) is commonly employed, as it closely corresponds to how humans perceive sound intensity[7].

Numerous epidemiological studies have demonstrated the adverse health effects of prolonged exposure to environmental noise, particularly traffic noise. These effects include cardiovascular diseases, heart attacks, and hypertension[9,10]. Additionally, exposure to excessive noise triggers both physical and psychological reactions, such as increased stress levels, cognitive impairment in children[11] , and even long-term auditory damage, including deafness[12]. Research conducted across Kurdistan has further highlighted the impact of short-term and long-term noise exposure on human health, leading to complications such as high blood pressure, heightened anxiety, sleep disturbances, and altered behavioral patterns[13-15].

As urbanization continues to expand, the number of people exposed to excessive noise pollution is increasing substantially. Individuals subjected to prolonged noise exposure may experience direct physiological effects or indirect consequences that contribute to chronic health conditions[16]. Studies have shown that workers exposed to an average noise level of 85 dBA for eight hours per day face a heightened risk of severe hearing impairment over a lifetime[17].

The industrialization of societies and the growing emphasis on urban living have exacerbated the issue, placing public health at risk[18]. For example, Turkey has recognized noise pollution as a significant public health challenge, prompting extensive research on the noise levels in its largest cities[19-23]. However, in many countries, including our own, environmental pollutants such as air, water, and soil contamination have received substantial attention, while noise pollution remains relatively underexamined. Despite its status as a major stressor affecting modern public health, noise pollution has yet to be fully acknowledged as a critical environmental issue.

Given the profound effects of noise pollution on human health and urban ecosystems, addressing this problem is imperative—particularly in rapidly urbanizing areas like Kalar City. This research aims to investigate the current state of noise pollution, identify its key contributors, and analyze its impact on public health and overall quality of life. The findings are expected to contribute to raising awareness and shaping strategies for noise reduction, ultimately enhancing urban living conditions.

2. Study area

The focus of this research is to assess the level of noise pollution in Kalar City, located in the Kurdistan Region. Kalar district lies in the southern part of the Sulaymaniyah Governorate, in northeastern Iraq, situated between the latitudes of 34° 55' 32" and 35° 19' 09" degrees north, and the longitudes of 45° 36' 34" and 45° 06' 55" degrees east (Figure 1). The city is built on a flat terrain with an elevation ranging from 200 to 290 meters above sea level. This geographical feature facilitates urban expansion without significant natural barriers[24]. As of 2024, Kalar City spans approximately 20.03 km². The study area is located 250 kilometers from Erbil, 160 kilometers from Kirkuk, 140 kilometers from Sulaymaniyah, and 180 kilometers northeast of Baghdad. Population growth has been a key factor contributing to noise pollution in the city. Between 2006 and 2023, Kalar experienced a substantial demographic shift. In 2006, the city's population was recorded at 102,101 people. The following year, in 2007, the number increased to 105,266—an increment of nearly 3,000, marking the beginning of continuous population growth. By 2023, statistics showed that Kalar's population had reached 188,686, demonstrating a significant increase over the years.

This rapid urban expansion and demographic growth highlight the rising concerns over noise pollution in Kalar City. Understanding these trends is essential for implementing strategies to mitigate environmental noise and enhance urban living conditions.

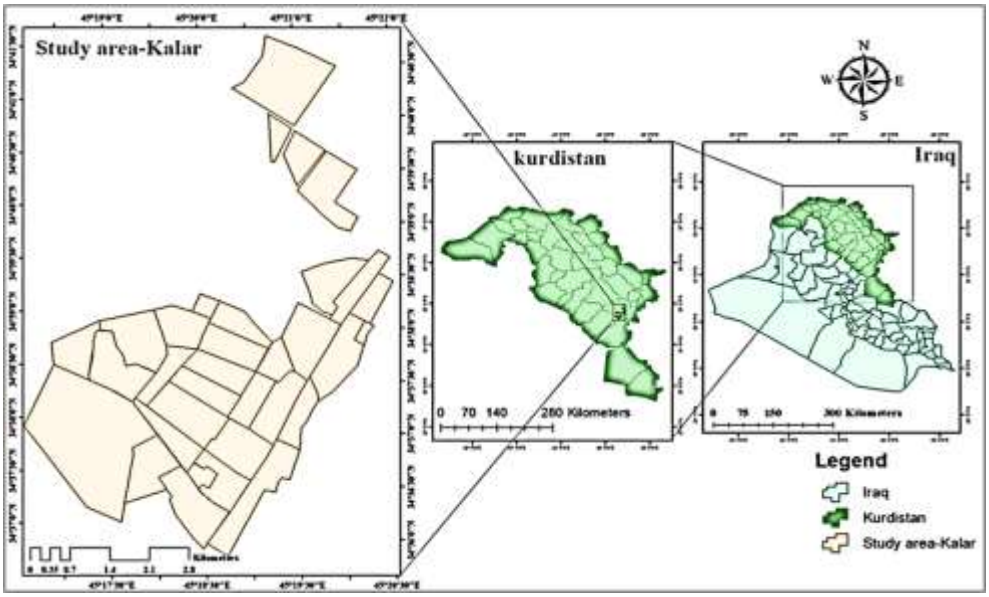

Figure 1: Location map of the studied area.

3 Materials and Methods

3. 1 Sound sources

Noise pollution in Kalar originates from a diverse range of sources, contributing to elevated sound levels across various parts of the city. Among the most significant contributors is road traffic, particularly from cars and motorcycles, with the latter being especially prevalent in both urban and residential areas. The continuous movement of vehicles, coupled with engine noise and frequent honking, results in sustained noise pollution throughout the day.

Additionally, industrial equipment and ongoing construction activities play a major role in increasing noise levels, particularly in commercial districts and expanding urban zones. The operation of heavy machinery, excavation work, and infrastructure development generate considerable acoustic disturbances, affecting both workers and nearby residents. Public events, such as sports gatherings, festivals, and other large-scale activities, further contribute to intermittent noise spikes, particularly during evenings and weekends when such events are more frequent. These temporary surges in noise can disrupt local neighborhoods, particularly in areas near event venues.

Beyond external environmental sources, neighborhood and domestic noise also play a significant role in overall sound pollution levels. Generators, household appliances, children playing outdoors, and loud music within residential areas contribute to periodic increases in ambient noise, particularly in densely populated sections of the city. These factors collectively shape the overall acoustic environment of Kalar.

The collected noise measurements from various locations in the city, detailed in Tables 1 and 2, provide a quantitative analysis of the intensity and distribution of sound levels across different zones, offering insight into the severity of noise pollution in distinct areas.

3. 2 Sample collection

To assess noise pollution in Kalar City, data were collected using an SL720 sound level meter. The device was mounted on tripods at a height of 1.5 meters above the ground and positioned 2.5 meters away from walls to ensure accurate measurements. The study was conducted over July and August 2024, aiming to evaluate environmental noise levels across different periods of the day.

Sound measurements were carried out in 18 neighborhoods at four distinct time intervals:

1) Morning: 7:00–8:00 a.m.

2) Midday: 11:00–12:00 p.m.

3) Evening: 5:00–6:00 p.m.

4) Night: 10:00–11:00 p.m.

Following data collection, ArcGIS 10.8.2 was used to create noise pollution maps, illustrating variations across different areas (as shown in Tables 1 and 2, Figure 2). Also, the day and night noise level formulation is called (Lden), or the measured equivalent noise level was used as input data in the calculation of the daytime noise level (LD) and the nighttime noise level (LN) (Equations 1 and 2)[25].

$$1)\ L_D = 10\log\left[\frac{1}{2}\left\{\left(10^{\frac{LAeqM}{10}}\right)+\left(10^{\frac{LAeqA}{10}}\right)\right\}\right]$$

$$2)\ L_N = 10\log\left[\frac{1}{2}\left\{\left(10^{\frac{LAeqE}{10}}\right)+\left(10^{\frac{LAeqN}{10}}\right)\right\}\right]$$

Where:

The A-weighted equivalent sound pressure level = LAeq

The equivalent sound pressure for the morning measurement = LAeqM

The equivalent sound pressure level for the afternoon measurement = LAeqA

The equivalent sound pressure level for the evening measurement = LAeqE

The equivalent sound pressure level for the night measurement = LAeqN

Daytime noise level = LD

To calculate the city's day-night noise level (LDN), the outcomes of equations 1 and 2 were utilized. The relation displayed in equation 3 was used to accomplish this[10].

$$3)\ L_{DN} = 10\log\left[\frac{1}{24}\{15\times 10^{L_D/10}+(9\times 10^{L_N+10/10})\}\right]$$

Equation 1 calculates the daytime sound level (LD), which is a key parameter for assessing noise exposure during daylight hours. This measurement helps evaluate the potential impact of noise pollution on daily activities such as work, study, and recreation. Similarly, Equation 2 quantifies the nighttime sound level (LN), offering valuable insights into the nocturnal soundscape. This assessment is crucial for understanding how nighttime noise levels affect sleep quality and overall well-being.

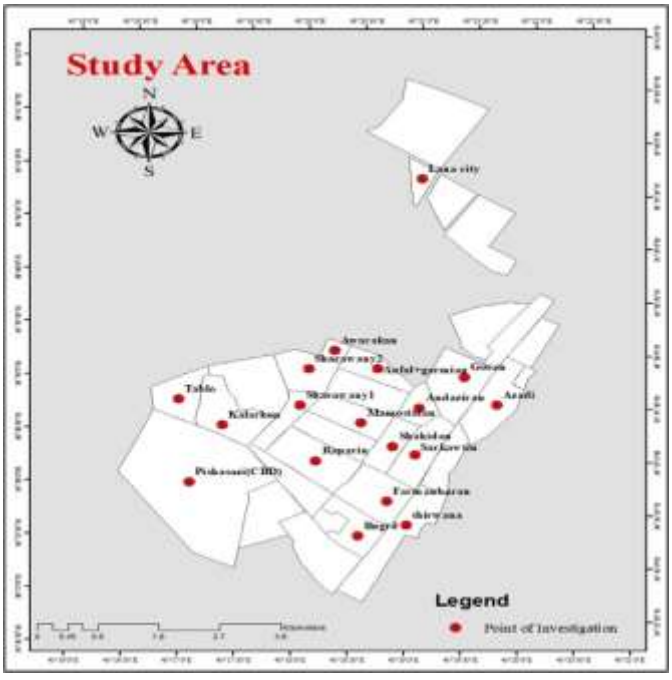

Figure 2: Point of Investigation in study Area

Finally, Equation 3 determines the day-night sound level (LDN), providing a comprehensive analysis of the city's acoustic environment across a full 24-hour cycle. By integrating daytime and nighttime data, this calculation offers a holistic view of noise pollution trends, aiding in the development of effective mitigation strategies.

4 Results and Discussions

The findings of this study provide a comprehensive assessment of noise pollution levels in Kalar City. Using an SL720 sound level meter, data was collected from 54 locations across 18 neighborhoods, enabling precise measurements of urban sound levels. The results, as summarized in Table 1, offer valuable insights into the distribution of noise pollution within the city and highlight areas with higher or lower exposure.

Table 1: The geographical location of the studied points for measuring noise pollution in Kalar.

N		Near location in the neighborhoods	SPL days (dB)				SPL nights (dB)				Mean SPL days (dB)		Mean SPL nights (dB)	
			7.00-10.00 a.m.	7.00-10.00 a.m.	12.00- 2:00 noon	12.00-2.00 noon	5.00-6.00 p.m.	5.00-6.00 p.m.	8.00- 11:00 p.m	8.00-11.00 p.m.	7.00-10.00	12:00- 2:00	5.00-6.00	8:00-11:00
			Max	min	max	min	Max	max	Min	max				
1	Farmanbaran	1 -Wanocentre for Educational Services	62.5	52.5	51.2	49.1	70.3	66.4	61.3	60.4	58	50	68	61
		2- Great masjid	79.3	63.2	79.6	65.5	87.1	81.3	61.5	56.8	71	73	84	59
		3-Bazar zanko	70.4	68.5	71.6	69.1	76.7	74.4	69.2	67.5	69	70	76	68
2	Bngrd	4-in Bazar	49.3	44.7	46.3	40.2	76.7	72.3	73.7	69.5	47	43	75	72
		5-Berlin supermarket	56.9	54.3	55.4	53.2	67.7	61.2	62.3	57.9	56	54	64	60
		6- bngrd park	58.3	50.7	56.9	55.7	70.4	66.7	71.8	68.7	55	56	69	70
3	Raparin	7-football	52.5	51.2	61.5	56.9	70.3	68.4	71.5	70.4	52	59	69	71
		8-Hospital Life	50.1	48.1	50.6	49.3	66.4	64.1	64.3	61.2	49	50	65	63
		9-the park	51.5	50.6	52.2	50.3	66.7	63.3	70.6	69.9	51	51	65	70
4	Andaziran	10- mahwy school	53.6	52.2	64.4	53.2	65.7	62.3	61.8	58.4	53	59	64	60
		11-andazirzn masjid	56.3	50.1	69.1	68.3	69.5	65.8	76.4	74.1	53	69	68	75
		12- stadium	51.6	49.2	50.7	45.9	71.6	70.3	76.1	73.6	50	48	71	75
5	Anfal+Garmian	13-Garmian Security Directorate	51.1	50.3	58.4	56.5	60.8	59.7	56.1	49.2	51	57	60	53
		14- bakur school	49.6	45.8	56.4	53.2	59.4	54.3	57.5	50.9	48	55	57	54
		15-yadgar mini market	49.4	44.7	56.6	54.3	68.7	60.2	66.3	54.5	47	55	64	60
6	Awarakan	16-school shid say nury	47.1	46.2	52.8	48.9	61.6	60.1	68.2	63.3	47	51	61	66
		17- the stadium	52.1	50.2	48.4	44.2	69.9	68.4	73.2	69.1	51	46	69	71
		18- park	48.3	43.4	52.2	47.9	65.7	64.9	68.9	67.4	46	50	65	68
7	Pishasazi(CBD)	19- masjid	74.9	63.2	70.8	67.4	92.9	90.5	56.2	54.2	69	69	92	55
		20-Puncherchi	72.4	60.6	75.8	63.7	89.1	88.3	59.5	56.1	67	70	78	58
		21-lacksmiths	78.3	70.6	69.7	68.1	89.4	86.4	55.6	53.3	75	69	88	54
8	Tablo	22-spy masjed	49.1	48.3	53.9	52.5	61.8	57.7	56.4	53.2	49	53	60	55
		23-Solav Design	53.6	52.8	65.4	53.2	58.4	56.3	54.9	50.9	53	59	57	53
		24-MiraChildren's Holi	46.6	43.2	58.3	53.4	58.7	50.2	56.3	54.5	45	56	54	55
9	Kalarkon	25-market zana	55.1	53.3	68.2	56.5	60.6	51.7	66.1	58.1	54	62	56	62
		25-kalar kon masjid	50.2	43.3	69.4	57.2	56.9	54.3	72.4	70.8	47	63	56	72
		27-school supply store	45.4	41.2	57.6	50.6	49.8	45.2	60.3	57.5	43	54	48	59
10	Mamostaian	28-Garmian General Directorate of Culture and Arts	53.1	44.3	46.4	40.5	69.3	62.3	65.8	61.4	49	43	66	64
		29-Directorate of Tourism	57.9	56.3	54.2	46.3	68.7	64.8	66.5	62.2	57	50	67	64
		30-Independent High Electoral Commission	56.5	53.9	60.4	57.6	61.5	60.3	62.1	57.6	55	59	61	60
11	Azadi	31-shops on the street	68.3	65.5	71.1	69.3	78.7	76.3	66.8	63.4	67	70	78	65
		32-daik Sports School	65.8	62.6	56.4	45.1	69.6	64.8	56.4	54.1	64	51	67	55
		33-salahadin masjid	58.3	54.5	55.6	53.2	66.7	58.3	56.1	54.6	56	54	63	55

12	**Sharawany2**	**34-Al-Rifai school**	52.1	50.3	55.2	44.2	65.7	62.3	61.8	58.4	51	50	64	60
		35-bazar shar	58.3	53.4	65.4	52.2	74.5	72.8	76.5	74.2	56	59	74	75
		36-shahidan Health Center	54.5	45.3	45.7	41.6	67.6	66.3	59.1	56.6	50	44	67	58
13	**Sharawany1**	**37-Fwll style**	56.2	53.5	66.2	52.5	60.6	60.6	67.2	58.7	55	59	61	63
		38-Kalar International School	54.2	52.3	54.4	52.2	66.9	62.3	77.4	74.9	53	53	65	76
		39-Work, training and occupation	56.7	52.3	54.8	52.8	64.5	58.8	68.7	59.7	55	54	62	64
14	**Shahidan**	**40- garmaser school**	47.2	46.6	58.7	53.5	61.6	60.6	67.6	65.7	47	56	61	67
		41-Juz and Luz Super Market	53.1	50.1	59.6	57.4	75.9	73.4	77.7	74.8	52	59	75	76
		42-shahidan masjid	44.3	45.4	52.2	51.9	64.2	59.8	57.9	56.2	45	52	62	57
15	**Sarkawtin**	**43-Amusment Park**	52.1	47.3	51.4	44.5	64.5	61.1	74.6	72.5	50	48	63	74
		44-Shadi food	61.2	59.3	64.2	61.3	69.7	65.3	78.3	75.2	60	63	68	77
		45-Kalar General Hospital	64.4	61.4	62.4	61.1	54.3	52.5	60.6	54.7	63	62	53	58
16	**Shirwana**	**46-khor private school**	47.1	46.2	52.8	50.9	62.3	59.2	68.4	61.2	47	52	61	65
		47-baxshen Medical Society	52.1	50.2	58.4	54.2	73.9	70.4	68.6	59.4	51	56	72	64
		48-Gullalla garmian masraf	58.3	55.4	68.2	64.9	74.6	71.8	60.9	58.3	57	67	73	60
17	**Lana city**	**49-market**	43.9	41.2	43.4	40.5	56.6	53.2	66.2	64.8	43	42	55	66
		50-park	42.8	42.2	43.2	42.1	60.9	54.3	69.7	63.4	43	43	58	67
		51-Eman masjid	43.3	40.5	42.1	40.2	61.4	59.6	57.5	51.2	42	41	61	54
18	**Goran**	**52-Mide School**	42.1	41.3	42.4	40.5	60.5	60.2	65.4	56.5	42	41	60	61
		53-park	50.2	49.3	49.2	46.3	68.7	65.8	71.3	68.1	50	48	67	70
		54-Karwan Weekly Market	56.5	53.9	60.4	57.6	65.2	62.9	69.6	65.9	55	59	64	68

Note: Noise levels during the specified hours in the study area 7.00-10.00 a.m, 12.00-2.00noon, 5.00-6.00 pm and 8.00-11.00 p.m.

This study utilized Table 1 along with Equations 1, 2, and 3 to derive Table 2, which presents a detailed analysis of noise levels across different periods of the day. Table 2 specifically categorizes noise pollution into daytime (LD), nighttime (LN), and day-night sound levels (LDN), offering valuable insights into the acoustic environment of Kalar

Table 2: Results of several places' equivalent noise levels in Kalar.

N	Neighborhoods	Location	L_D (dBA)	L_N (dBA)	L_{DN} (dBA)	Mean L_D(dBA)	Mean L_N(dBA)	Mean L_{DN}(dBA)
		1	56	66	72			
1	**Farmanbaran**	2	72	81	87			
		3	69	74	80	66	74	80
		4	45	73	79			
2	**Bngrd**	5	55	62	68			
		6	56	70	76	52	68	74
		7	57	70	76			
3	**Raparin**	8	50	64	70			
		9	51	68	74	53	67	73
		10	57	62	68			
4	**Andaziran**	11	66	73	79			
		12	49	73	79	57	69	75
		13	55	58	64			
5	**Anfal+garmian**	14	53	55	61			
		15	53	62	68	54	58	64
		16	49	64	70			
6	**Awarakan**	17	49	70	76			
		18	48	67	73	49	67	73
		19	69	89	95			
7	**Pishasazi(CBD)**	20	67	75	81			
		21	72	85	91	69	83	89
		22	51	58	64			
8	**Tablo**	23	57	55	6			
		24	53	55	61	53	56	62

9	**Kalarkon**	25 26 27	60 60 51	60 69 56	66 75 62	57	62	68
10	**Mamostaian**	28 29 30	47 55 57	65 66 61	71 72 67	53	64	70
11	**Azadi**	31 32 33	69 57 55	75 64 61	81 70 67	62	67	73
12	**Sharawany2**	34 35 36	51 58 48	62 75 65	68 81 71	52	67	73
13	**Sharawany1**	37 38 39	57 53 55	62 73 63	68 79 69	55	66	72
14	**Shahidan**	40 41 42	54 57 50	65 76 60	71 82 66	54	67	73
15	**Sarkawtin**	43 44 45	49 62 63	71 75 56	79 81 64	58	67	75
16	**Shirwana**	46 47 48	50 54 64	63 70 70	69 76 76	56	68	74
17	**Lana city**	49 50 51	43 43 42	63 65 59	69 71 65	43	62	68
18	**Goran**	52 53 54	42 49 57	61 69 66	67 75 72	49	65	71

Note: Noise levels during the specified hours in the study area LD = Day time noise level

Table 3: Description of noise quality during daytime and night.

Daytime (dB)	Night time(dB)
0 – 30 outstanding Quality	0 – 30 outstanding Quality
31– 40 Very good quality	31– 40 Very good quality
41 – 60 Good quality	41 – 50 Good quality
61 – 75 Satisfactory quality	51 – 65 Satisfactory quality
76 – 90 Unsatisfactory	66 – 75 Unsatisfactory
91 – 110 Dangerous quality levels	76 – 95 Dangerous quality levels
>111 Not permitted over	> 95 Not permitted over

An analysis of Table 2, based on the model presented in Table 3, reveals that the Central Business District (CBD) has the highest nighttime equivalent noise level in Kalar City, reaching 83 dBA. This elevated level is primarily due to the area's role as a commercial and transportation hub, where activity remains high well into the night. The large number of vehicles navigating the road network, combined with extensive business operations, significantly contributes to sustained noise pollution.

These findings align with research by Essandoh and Armah [11], which suggests that road traffic and commercial activities are the primary sources of environmental noise. Across various neighborhoods, noise levels fluctuate depending on the area's density and activity patterns. For example, Farmanbaran records a daytime level of 66 dBA, rising to 74 dBA at night, while Bngrd experiences lower noise levels at 52 dBA during the day, increasing to 68 dBA at night.

Similarly, Raparin sees daytime levels of 53 dBA, rising to 67 dBA in the evening. Other neighborhoods follow similar trends, such as Andaziran with 57 dBA during the day and 69 dBA at night, and Anfal + Garmian, where daytime noise reaches 54 dBA, slightly dropping to 58 dBA at night. In Awarakan, noise levels are 49 dBA during the day, increasing to 67 dBA at night, while Table records 53 dBA in daylight hours, decreasing to 56 dBA at night. Kalarkon and Mamostaian show moderate variations, with Kalarkon registering 57 dBA during the day and 62 dBA at night, whereas Mamostaian records 53 dBA during the day and 64 dBA at night.

Azadi experiences 62 dBA during the day, with a slight increase to 67 dBA at night, while Sharawany 2 sees a decrease from 52

dBA during the day to 66 dBA at night. Similarly, Shahidan has daytime levels of 54 dBA, rising to 67 dBA at night, whereas Shirwana records 56 dBA during the day and 68 dBA in the evening. Lana City, one of the quieter areas, records 43 dBA during the day, increasing to 62 dBA at night.

Finally, Goran has 49 dBA during the day and 65 dBA at night. Figures 3 and 4 visually illustrate these patterns, further emphasizing the variation in noise levels throughout different parts of Kalar City. These findings provide a valuable foundation for understanding urban noise pollution and identifying strategies to mitigate its impact on public health and quality of life.

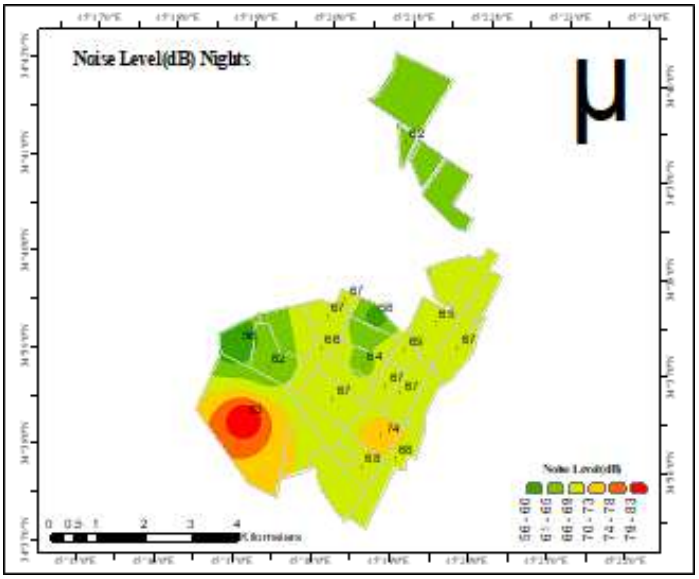

Figure 3: Night Time Noise Map.

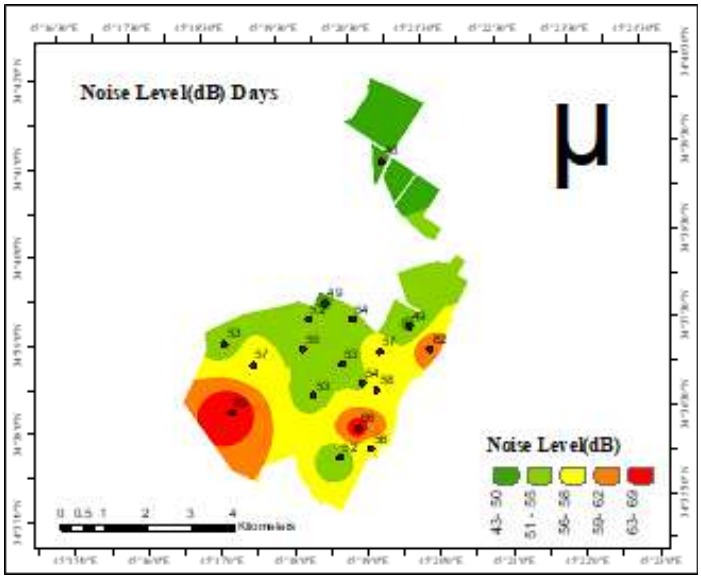

Figure 4: Day Time Noise Map.

Table 3 presents the measured noise quality levels for both daytime and nighttime in Kalar City. Analyzing the data reveals that nighttime noise quality is significantly poorer compared to daytime levels. This disparity is largely due to fluctuating noise levels in the Central Business District (CBD), which range from 56 to 83 dBA during the night. The higher nighttime noise levels can be attributed to continued commercial activity, heavy traffic, and public movement after dark, leading to sustained noise pollution. This pattern suggests that noise control measures may be necessary to improve nighttime acoustic conditions and mitigate potential health impacts on residents.

Table 4: displaying the City's daytime and overnight noise quality levels.

	Day time		Night time	
LOCATIONS	**Leq (dBA)**	**Noise Quality Description**	**Leq (dBA)**	**Noise Quality Description**
Farmanbaran	66	Satisfactory quality	74	Unsatisfactory
Bngrd	52	Good quality	68	Unsatisfactory
Raparin	53	Good quality	67	Unsatisfactory
Andaziran	57	Good quality	69	Unsatisfactory
Anfal+garmian	54	Good quality	58	Satisfactory quality
Awarakan	49	Good quality	67	Unsatisfactory
Pishasazi(CBD)	69	Satisfactory quality	83	Dangerous quality levels
Tablo	53	Good quality	56	Satisfactory quality
Kalarkon	57	Good quality	62	Satisfactory quality
Mamostaian	53	Good quality	64	Satisfactory quality
Azadi	62	Satisfactory quality	67	Unsatisfactory
Sharawany2	52	Good quality	67	Unsatisfactory
Sharawany1	55	Good quality	66	Unsatisfactory
Shahidan	54	Good quality	67	Unsatisfactory
Sarkawtin	58	Good quality	67	Unsatisfactory
Shirwana	56	Good quality	68	Unsatisfactory
Lana city	43	Good quality	62	Unsatisfactory
Goran	49	Good quality	65	Unsatisfactory

An analysis of Table 4 reveals noticeable variations in noise quality across different areas of Kalar City, distinguishing between daytime and nighttime conditions. During the day, neighborhoods such as Bngrd, Raparin, Andaziran, and Anfal + Garmian exhibit good noise quality, with average Leq values ranging from 49 dBA to 57 dBA, indicating a relatively peaceful acoustic environment.

However, nighttime conditions show a clear uptick in noise levels across several areas. Farmanbaran, Pishasazi (CBD), and Azadi record unsatisfactory or even hazardous noise levels, with Pishasazi (CBD) reaching 83 dBA at night, making it one of the most affected locations. In contrast, areas such as Tablo, Kalarkon, and Mamostaian maintain satisfactory noise conditions throughout the day and night, with Leq values between 53 dBA and 64 dBA. Conversely, Shirwana, Sharawany 2, and Goran experience elevated nighttime noise levels, making them less suitable for restful environments.

Although Lana City and Goran exhibit relatively quiet daytime conditions, their nighttime noise levels remain unsatisfactory, reinforcing the disparity in noise quality throughout Kalar City. To aid residents in understanding these variations, Figure 5 illustrates the day-night noise levels, helping individuals assess the suitability of different neighborhoods for living and working while maintaining a healthy acoustic environment. This visual representation serves as a practical tool for evaluating urban noise exposure and ensuring a more serene lifestyle.

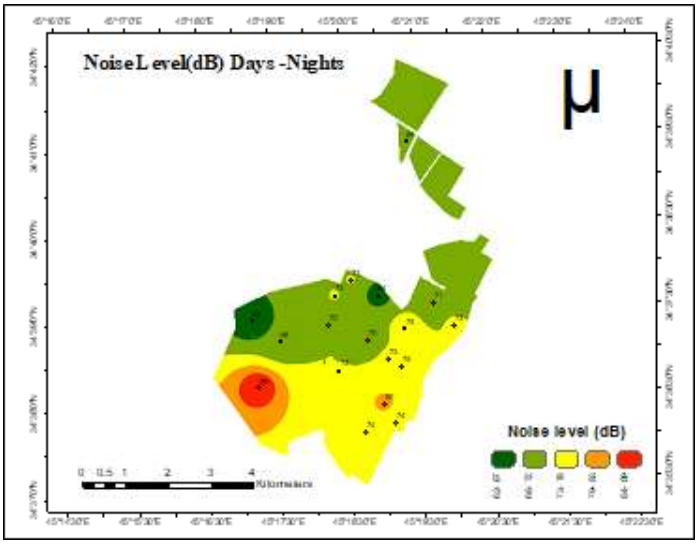

Figure 5: Days-Nights Time Noise map

Conclusion

This research examined noise pollution across various neighborhoods in Kalar, Kurdistan-Iraq, using data collected from an SL720 sound level meter over a two-month period (July and August). Measurements were recorded at different times throughout the day and night to assess variations in sound levels. The findings indicate that daytime noise levels in the city generally maintain good quality, with most areas experiencing moderate and acceptable sound levels. However, nighttime readings (LN) reveal a more concerning situation, particularly in the Pishasazi CBD area, where noise levels reach 83 dBA, classifying it within the "hazardous quality" range (76–95 dBA). This extreme level of noise pollution is largely attributed to the area's continuous commercial activity and high traffic volume after dark.

In contrast, most neighborhoods experience "unsatisfactory" nocturnal noise levels, fluctuating between 66–75 dBA. Only a few locations manage to maintain "satisfactory quality" conditions, ranging from 51–65 dBA during nighttime hours. Further analysis of day-night noise levels (LDN) highlights the cumulative impact of noise exposure in the city. The CBD area records the highest LDN at 89 dBA, followed by Farmanbaran with 80 dBA. Residential areas generally range between 68–75 dBA, while the quietest neighborhood, Tablo, maintains an LDN of 62 dBA.

This data reveals multiple significant concerns:

The findings indicate a severe decline in auditory quality during nighttime hours, with noise levels becoming particularly problematic across multiple areas of Kalar City. The Central Business District (CBD) consistently exceeds permissible noise thresholds, reaching hazardous levels due to sustained commercial activity and high traffic volume. Residential areas also experience alarming noise pollution, especially at night, as elevated sound levels interfere with sleep quality and overall well-being.

Notably, no neighborhoods maintain an "Excellent" or "Very Good" noise quality rating, highlighting the widespread impact of environmental noise across the city. These results emphasize the urgent need for noise mitigation strategies to improve living conditions and create a more sustainable urban environment.

These data indicate an immediate necessity for noise management techniques, specifically:

The findings of this study highlight the pressing need for targeted noise mitigation strategies in Kalar City, particularly during nighttime hours. Implementing nocturnal noise control measures in the Central Business District (CBD) is essential, as this area consistently exceeds permissible noise thresholds due to continuous commercial activity and heavy traffic. Additionally, the establishment of buffer zones between commercial and residential sectors could help reduce sound transmission and create quieter living environments.

Traffic-related noise remains a major concern, necessitating traffic management systems designed for noise abatement, such as optimized road layouts, speed regulations, and noise barriers. Furthermore, special attention should be given to residential zones that experience significant nighttime noise increases, ensuring that urban planning integrates soundproofing measures and controlled activity hours to improve the overall acoustic quality of these areas.

This study underscores that Kalar faces considerable challenges in maintaining a healthy auditory environment, especially at night. Prompt intervention through urban planning and structured noise reduction policies is crucial to safeguarding public well-being and enhancing the overall quality of life for residents.

Conflict of interest

None.

Author's Contributions

This study was entirely conceptualized, designed, and executed by the author, focusing on noise pollution in residential areas of Kalar, Kurdistan-Iraq. Every aspect of the research, including data collection, analysis, and manuscript preparation, was independently conducted, ensuring a comprehensive and unbiased examination of the issue.

References

[1] Anomohanran, O., Iwegbue, C., Oghenerhoro, O. & Egbai, J. Investigation of environmental noise pollution level of Abraka in Delta State, Nigeria. *Trends in applied sciences research* **3**, 292-297 (2008).

[2] Guedes, I. C. M., Bertoli, S. R. & Zannin, P. H. Influence of urban shapes on environmental noise: a case study in Aracaju—Brazil. *Science of the Total Environment* **412**, 66-76 (2011).

[3] Organization, W. H. in *United Nations road safety collaboration: a handbook of partner profiles* (2005).

[4] Barbosa, A. S. & Cardoso, M. R. Hearing loss among workers exposed to road traffic noise in the city of São Paulo in Brazil. *Auris Nasus Larynx* **32**, 17-21 (2005).

[5] Ghatass, Z. F. Assessment and analysis of traffic noise pollution in Alexandria City, Egypt. *World Applied Sciences Journal* **6**, 433-441 (2009).

[6] Babisch, W., Beule, B., Schust, M., Kersten, N. & Ising, H. Traffic noise and risk of myocardial infarction. *Epidemiology* **16**, 33-40 (2005).

[7] Alam, J. B., Alam, M. J. B., Rahman, M., Dikshit, A. & Khan, S. Study on traffic noise level of Sylhet by multiple regression analysis associated with health hazards. *Journal of Environmental Health Science & Engineering* **3**, 71-78 (2006).

[8] Villoria, E. M. *et al.* Study about the consequences of different sound pressure levels emitted by magnetic resonance imaging equipment. *Revista CEFAC* **18**, 27-32 (2016).

[9] Van Kempen, E. & Babisch, W. The quantitative relationship between road traffic noise and hypertension: a meta-analysis. *Journal of hypertension* **30**, 1075-1086 (2012).

[10] Bendokiene, I., Grazuleviciene, R. & Dedele, A. Risk of hypertension related to road traffic noise among reproductive-age women. *Noise and Health* **13**, 371-377 (2011).

[11] Babisch, W. The noise/stress concept, risk assessment and research needs. *Noise and health* **4**, 1-11 (2002).

[12] Essandoh, P. K., Armah, F. A., Afrifa, E. K. & Pappoe, A. N. Determination of ambient noise levels and perception of residents in halls at the University of Cape Coast, Ghana. *Environment and Natural Resources Research* **1**, 181 (2011).

[13] Aziz, S. Q. Environmental noise pollution in Erbil City, Iraq: Monitoring and solutions. *Caspian Journal of Applied Sciences Research* **1**, 14-22 (2012).

[14] Ali, S. S. & Albayati, A. H. K. Statistical modeling for traffic noise: The case of Kirkuk City. *Engineering, Technology & Applied Science Research* **12**, 9108-9112 (2022).

[15] Elias, B. H., Alhamdi, W. A. & Khalil, M. H. Impacts of noise pollution on arterial systolic blood pressure, diastolic blood pressure, heart pulse rate and blood oxygen saturation of nurses in duhok hospitals–iraq. *Journal of Duhok University*, 138

[16] Kryter, K. D. The effects of noise on man. (Elsevier, 2013).

[17] Lutman, M. What is the risk of noise-induced hearing loss at 80, 85, 90 dB (A) and above? *Occupational medicine* **50**, 274-275 (2000).

[18] Abo-Qudais, S. & Abu-Qdais, H. Perceptions and attitudes of individuals exposed to traffic noise in working places. *Building and Environment* **40**, 778-787 (2005).

[19] Sisman, E. E. & Unver, E. Evaluation of traffic noise pollution in Corlu, Turkey. *Scientific Research and Essays* **6**, 3027-3033 (2011).

[20] Doygun, H. & Kuşat Gurun, D. Analysing and mapping spatial and temporal dynamics of urban traffic noise pollution: a case study in Kahramanmaraş, Turkey. *Environmental Monitoring and Assessment* **142**, 65-72 (2008).

[21] Ozer, S., Irmak, M. A. & Yilmaz, H. Determination of roadside noise reduction effectiveness of Pinus sylvestris L. and Populus nigra L. in Erzurum, Turkey. *Environmental monitoring and assessment* **144**, 191-197 (2008).

[22] Ozer, S., Yilmaz, H., Yesil, M. & Yesil, P. Evaluation of noise pollution caused by vehicles in the city of Tokat, Turkey. *Scientific research and essay* **4**, 1205-1212 (2009).

[23] Yilmaz, H. & Ozer, S. Evaluation and analysis of environmental noise pollution in the city of Erzurum, Turkey. *International Journal of Environment and Pollution* **23**, 438-448 (2005).

[24] Mohammed, A. H. Representation and mapping analysis of changes in land cover in the Kalar district using digital processing. *Journal of Garmian University* **9**, 479-497 (2022).

[25] Olayinka, O. S. & Abdullahi, S. A statistical analysis of the day-time and night-time noise levels in Ilorin Metropolis, Nigeria. *Trends in Applied Sciences Research* **3**, 253-266 (2008).