MAS Journal of Applied Sciences
Uygulamalı Bilimler Dergisi
ISSN: 2757-5675
masjaps.com

OPEN ACCESS

DOI: http://dx.doi.org/10.5281/zenodo.14359242

Araştırma Makalesi / Research Article

Mapping Environmental Noise from Road Transportation Using SoundPLAN: The Case of Harran University Osmanbey Campus

Tuba RASTGELDİ DOGAN [1*], Can Bülent KARAKUŞ [2], Ali SUZERGOZ [1]
[1] Harran University, Faculty of Engineering, Department of Environmental Engineering, Şanlıurfa
[2] Sivas Cumhuriyet University, Faculty of Fine Arts and Design, Department of Urban and Regional Planning, Sivas
*Corresponding author: trastgeldi@harran.edu.tr

Received: 16.08.2024 **Accepted**: 30.09.2024

Abstract
Noise pollution is a critical environmental problem that negatively affects human health and quality of life. It is particularly significant in educational environments, where excessive noise can impair students' learning abilities, concentration, and overall academic performance. This study evaluates noise pollution on the Osmanbey Campus of Harran University, with a specific focus on traffic-related noise levels. Measurements were conducted at 11 key points during the Ld (07:00–19:00), Le (19:00–23:00), and Ln (23:00–07:00) periods. The SoundPlan 7.4 model was used to generate noise maps and analyze the distribution of environmental noise across the campus. Road traffic was identified as the main source of noise, especially in areas with high vehicle density, such as intersections and bus stops. The results determined that noise levels on campus exceeded the thresholds established by the WHO across all periods. The highest noise level was recorded at Point 2 during the day (74.90 dBA), a busy area with frequent bus activity and human movement. The lowest level, measured at Point 5 during the night (56.40 dBA), was in a quieter area near the Faculty of Sports Sciences but still slightly above the recommended nighttime limits. These findings underscore the importance of addressing noise pollution, particularly in educational settings, to support a conducive learning environment. Suggested mitigation strategies include traffic management, acoustic landscaping, and continuous noise monitoring. Additionally, promoting sustainable transportation options, such as cycling can contribute to reducing noise levels and fostering a healthier campus atmosphere.

Keywords: Enviromental noise, noise pollution, sound level measurement, university campus

1. Introduction

Noise pollution has emerged as one of the major issues arising from modern urbanization and human activities, becoming an increasingly significant environmental issue in contemporary society. Noise refers to unwanted or harmful sound that disrupts normal daily life (Iannace et al., 2021). It has long been recognized as a significant threat to human health, communication and overall well-being, negatively impacting the quality of life (Goines and Hagler, 2007). Common sources of noise include traffic, industrial activities and urbanization (Kumari et al., 2023). As urban areas continue to grow, traffic volumes increase to meet the needs of a rising population, leading to heightened noise pollution. This continuous rise in vehicle numbers is exacerbating the problem, making road traffic noise the primary source of annoyance (Khan et al., 2018). The persistent intrusion of such noise disrupts daily life and contributes to various health issues, further emphasizing its growing dominance as a public concern.

Noise pollution is typically defined by its intensity, duration, and frequency. It is often measured in decibels (dB). However, in environmental noise assessments, the use of A-weighted decibels (dBA) is more common, as it accounts for the varying sensitivity of the human ear to different frequencies. A-weighted decibels provide a more accurate evaluation of noise levels, considering that low and high frequencies are less perceptible to humans. According to the World Health Organization (WHO) report (WHO, 2019), it is strongly recommended that the average noise exposure during daytime hours be reduced to below 53 dBA for road traffic-related noise, as this level of A-weighted equivalent sound pressure (LAeq) is associated with adverse health effects. Noise levels above this threshold are linked to various negative health impacts. Understanding noise impact is crucial for managing its effects on urban populations. Numerous studies have shown that continuous exposure to high noise levels can not only cause hearing loss (Redman et al., 2022; Welch et al., 2023), but also lead to psychological health issues such as stress, anxiety, depression and fatigue (Ma et al., 2020; Stansfeld et al., 2021; Petri et al., 2021; Gong et al., 2022). According to a European Environment Agency report, road noise pollution is associated with approximately 10,100 premature deaths annually across 32 European countries, highlighting its critical role as an escalating environmental and health concern (Peris et al., 2020).

The increase in noise pollution is attributed to several factors, including traffic (Wang et al., 2022), construction activities (Lee and Hong, 2019), social interactions and various events (Sors et al., 2019). The resulting noise pollution not only negatively affects attention and learning processes in the short term but can also impact students' academic performance due to prolonged and continuous exposure (Shukla and Tandel, 2024). Specifically, classroom teaching requires a process of thinking and comprehension, and noise on campus can distract students, which can hinder the effectiveness of teaching. Furthermore, individuals exposed to prolonged noise are likely to experience psychological and cognitive effects, not only during class but also afterwards. Generally, verbal communication, teaching and learning, mental activities and sleep are often the most affected (Gilani and Mir, 2022; Natarajan et al., 2023).

In recent years, the level of noise on university campuses has become increasingly complex and varied. A study at the University of Technology Malaysia examined environmental noise problems. Within the scope of the study, one-hour measurements were taken at 24 different points on the campus during working hours. According to the results, 95.8% of the measurements exceeded the permissible limits determined by the Department of Environment (Haron et al., 2015). A study conducted at the Çukurova University campus examined the effects of traffic-related noise pollution between 2010 and 2017. The study created noise maps during the day and evening hours using SoundPLAN 7.4 software, and these maps were compared with the noise threshold values determined by the European Union. The results showed that noise levels of 60 dB(A) and above increased in 2017 compared to 2010, and faculty buildings that did not provide protection against noise were particularly affected (Çolakkadıoğlu et al., 2018). A study conducted at the Federal University of Juiz de Fora in Brazil examined the effects of noise pollution on user perception and behavior. Sound measurements made at 32 outdoor and 11 indoor locations were compared with national standards and the recommendations of the WHO. According to the results, 87% of outdoor measurements exceeded NBR 10.151 limits, and 53% exceeded WHO limits (de Souza et al., 2020). In a study conducted at the University of Jos in Nigeria, noise levels on campus were examined and traffic and students were identified as the main noise sources. Most of the measurements made at 17 locations were observed to be above the WHO standards. A value above the educational area limit of 50 dB was recorded (Akintunde et al., 2020).

In this study, noise pollution on the Osmanbey Campus of Harran University was examined through measurements taken at 11 different points using the SoundPlan 7.4 model. Measurements were conducted during the day, evening, and night, and the collected data were compared with the recommended limit values outlined in the WHO Environmental Noise Guidelines for the European Region. The highest daytime noise level was recorded at point 2, with 74.90 dBA. The lowest value was observed at point 5, with 63.10 dBA. In areas with numerous educational buildings and student dormitories within the campus, noise levels tend to rise due to heavy pedestrian and vehicle traffic. This study aims to improve the understanding of noise pollution within the campus and contribute to the development of strategies to mitigate this issue.

2. Materials and Methods

2.1 Study area and selection of measure points

For this study, Harran University's Osmanbey Campus was selected as the primary site for noise pollution measurements (Figure 1). Harran University, located in Şanlıurfa, in Türkiye’s Southeastern Anatolia Region, was founded in 1987. Educational activities are conducted across three campuses: Osmanbey, Yenişehir, and Eyyübiye. The Osmanbey Campus, established in 2003, spans 15 km² and serves as the main hub of the university's academic and research activities within its total area of 27 km² (Rastgeldi Dogan, 2019). Additionally, the Osmanbey Campus is approximately 18 km from the city center, which means that staff and students typically travel to the campus by bus or private vehicles.

The university comprises 13 faculties, 3 vocational schools, 1 state conservatory, 14 vocational high schools, 3 institutes, and 14 research and application centers. As of 2023, Harran University hosts 28,716 students, making it a bustling academic hub (Harran University, 2023). This substantial student and staff population contributes to potential noise pollution, particularly from traffic. In large campuses like Osmanbey, managing noise levels and mitigating environmental impacts are critical areas of focus.

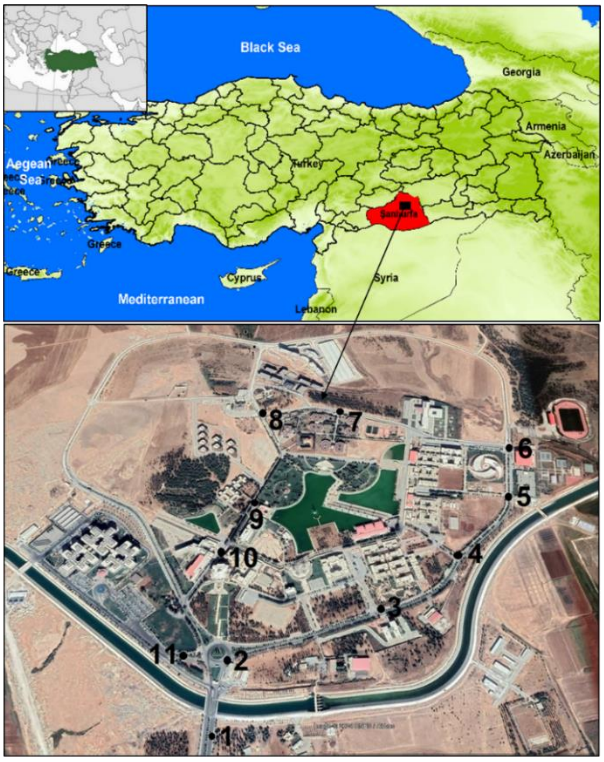

Figure 1. Study area location and noise measurement points within the campus

Within the scope of this study, a total of 11 points were selected in Harran University Osmanbey Campus where road noise levels could be observed intensively. These points were determined especially in the intersections located within the campus and were determined in order to determine the noise sources and to observe their distribution in a balanced way. The measurement points and coordinates are presented in Table 1.

Table 1. Measurement points and coordinates for noise observation

X Coordinate	Y Coordinate	Measurement Point	Name Of The Measuring Point
499608.42	4114716.71	1	Campus Entrance
499640.72	4114902.41	2	Collection Stop
500024.24	4115036.39	3	Science-Literature Junction
500271.82	4115226.57	4	Agriculture Faculty Junction
500459.52	4115480.38	5	"Besyo" Junction
500490.36	4115642.66	6	Engineering Faculty Junction
499875.82	4115862.80	7	Dormitory Stop
499646.47	4115818.90	8	Mosque Junction
499660.47	4115501.20	9	Lodging Junction
499542.36	4115224.04	10	Theology Faculty Junction
499566.22	4114811.79	11	Hospital Junction

It is seen that Harran University is at a critical point in terms of noise pollution due to the increase in vehicle density parallel to the rapidly increasing number of students and staff in recent years and the visitor traffic coming to the hospital located on the campus. One of the selected measurement points also covers the vicinity of the hospital on the campus, which enabled the study to represent different density points within the university.

2.2 Using the soundplan model for noise measurement

For making a noise map of Osmanbey campus is used SoundPLAN 7.4 (64-bit) software with the NMPB 96 calculation method to process modeling data. SoundPLAN has been on the market since 1986 (WKC Technology Ltd., 2024). It enjoys the largest number of noise simulation software users worldwide. The complete noise propagation into the environment makes this software the ideal tool for engineers working in the fields of noise planning, noise in the workplace, noise mapping and as part of general environmental assessment studies (Öngel and Sezgin, 2017; Çolakkadıoğlu et al., 2018; Chan et al., 2019). The unsurpassed numerical and graphical presentations make it easy to explain findings to the public and to researchers. It is used by governments, consultants and researchers in many countries and is the world's leading environmental prediction software. The first step in the mapping process involved importing the site plan of the Harran University's Osmanbey campus into SoundPLAN. The campus's topographical characteristics were then modeled in three dimensions to ensure accurate representation. This step provided a detailed foundation for noise modeling and analysis, enabling the integration of relevant environmental and structural parameters into the simulation process.

According to the recommendations of the WHO Environmental Noise Guidelines for the European Region, the following indicators are used to establish noise standards: setting environmental noise level limits, assessing and predicting noise exposure, creating strategic noise maps, and planning measures for noise protection.

Indicator for noise disturbance during the day (Ld) or daily noise level which is A-equivalent long-term average sound level.

Indicator for noise disturbance during the evening (Le) or evening noise level which is A-equivalent long-term average sound level.

Indicator for noise disturbance during the night (Ln) or night noise level which is A-equivalent long-term average sound level.

According to the Regulations for application of noise indicators, additional indicators of noise, method of measuring noise and methods of assessment indicators for noise in the environment the indicator for noise disturbance during the day (Ld) covers the period of 12 hours, from 07:00 to 19:00, indicator for noise disturbance during the evening (Le) covers the period of 4 hours, from 19:00 to 23:00 and indicator for noise disturbance during the night (Ln) covers the period of 8 hours, from 23:00 to 07:00.

In the SoundPLAN Manager, emission time slices are defined for analysis. Figure 2 provides an overview of the software interface.

Figure 2. The interface of the SoundPLAN software

The following fundamental acoustic equations are applied to determine the sound pressure level in the noise mapping process:

$$L_{Aeq,T} = 10\log\left[\frac{1}{t_2 - t_1}\int_{t_2}^{t_1}\frac{p_A^2(t)}{p_0^2}dt\right] \quad (1)$$

where LAeq,T is the equivalent continuous A-weighted sound pressure level, in dB, determined over a time interval T starting at t1 and ending at t2; po is the reference sound pressure (20 µPa); and pA(t) is the instantaneous weighted sound pressure of the sound signal.

$$L_P = L_w - 20\log(r) - 8 \quad (2)$$

Lp represents the sound pressure level in dB(A), Lw refers to the sound power level of the source in dB(A), and r is the distance over which the noise propagates from a point source on a flat surface. The sound power level can be input directly or via the software's library.

In this study, all parameters necessary for constructing the noise map were carefully defined and incorporated using the SoundPlan 7.4 software. These parameters encompassed details about buildings, area sources, and traffic characteristics. Campus buildings were categorized according to their functions, and key attributes such as their heights and number of floors were included in the model. Similarly, traffic-related inputs, including lane dimensions, speed limits, and vehicle flow rates, were also specified to ensure accurate noise simulations.

2.3. Method

The measurements were conducted by technical personnel using the Testo 861-1 sound level meter as shown in Figure 3, available at Harran University's Environmental Engineering Air and Noise Laboratory, in accordance with ISO 1996-1 and ISO 1996-2 standards. This Type 2 device is calibrated with a certified calibrator at the beginning of each measurement and can perform A-weighted decibel (dBA) measurements, accurately reflecting human auditory sensitivity. Measurements were taken during peak traffic hours across the daytime, evening and nighttime periods, ensuring reliable data for environmental noise pollution analysis. Vehicle counts were conducted at an observation point with a clear view of the road, using camera recordings to record traffic during the specified time frames.

Figure 3. Noise measurement process and the Testo 861-1 noise measuring device

The evaluation of traffic noise levels was conducted with reference to the WHO Environmental Noise Guidelines for the European Region (World Health Organization, 2018), which recommend a threshold of 53 dBA for Ld and Le (day and evening), and 45 dBA for Ln (nighttime noise). These values served as reference standards to evaluate the environmental noise levels at different times of the day. They were critical in determining whether the measured noise levels on campus exceeded acceptable limits, thus identifying areas that required urgent intervention. The comparison of the measured noise levels with these thresholds provided a comprehensive assessment of noise pollution on the Osmanbey Campus.

3. Results and Discussion

Analysis of noise measurements taken across the Osmanbey Campus, focusing on day (Ld), evening (Le), and night (Ln) levels, reveals critical insights into the acoustic environment of the area. The results are presented in Table 2, which summarizes the calculated and measured values along with their differences for each observation point. These findings facilitate a detailed examination of noise dynamics across various campus zones, enabling the identification of high-noise areas. Notably, all values measured for Ld, Le, and Ln exceed the limits recommended by the WHO, which specifies thresholds of 53 dBA for daytime and evening and 45 dBA for nighttime. This significant exceedance is a matter of concern, as prolonged exposure to such high noise levels can lead to adverse health and well-being impacts on campus residents and visitors. The data underline the urgent need for targeted noise mitigation strategies to address these critical areas and improve the acoustic quality of the campus environment.

Table 2. Comparison of Calculated and Measured Noise Levels Across Measurement Points

	Calculated Value		
Measurement Point	**Ld**	**Le**	**Ln**
1	66,50	60,10	58,30
2	74,90	67,30	64,80
3	72,60	66,00	63,50
4	66,90	56,30	62,00
5	63,10	56,70	56,40
6	62,50	56,60	58,90
7	65,70	62,10	62,60
8	65,70	60,90	60,40
9	66,80	60,00	60,10
10	66,60	61,20	57,00
11	72,30	66,70	60,40

3.1. Ld noise measurement

Ld (07:00-19:00) is the time period when the campus is at its busiest. During this period, factors such as traffic density, student and staff mobility significantly increase noise levels. Daytime measurements provide a critical database for understanding the noise levels across the campus and identifying particularly busy areas. Figure 4 presents the Ld values measured at Osmanbey Campus, allowing visualization and analysis of noise levels in different areas.

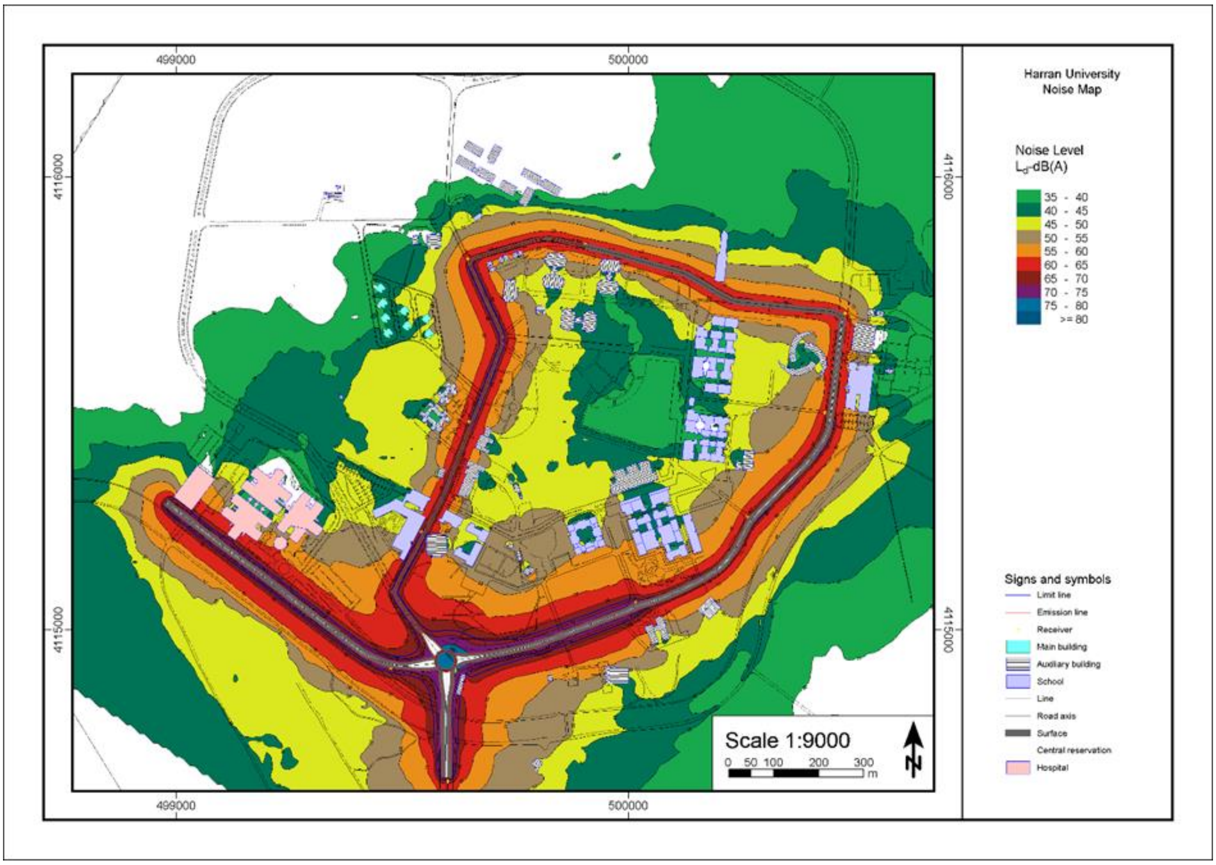

Figure 4. Daytime noise levels (Ld) across campus

The noise levels (Ld) measured during the daytime reveal the basic acoustic structure throughout the campus. The data calculated with SoundPlan 7.4 software provide a more comprehensive picture compared to the measured values, as it takes into account not only vehicle traffic but also factors that may affect the propagation of noise (distance of buildings to the road, wooded areas, road width). The Ld values obtained at Osmanbey Campus showed significant variation. These differences were closely related to the functional and environmental conditions of different areas within the campus. The highest Lday value was measured in the 2nd point area (74.90 dBA). This area is one of the busiest points on the campus. It is the last stop of buses coming from the city and a transfer point where students who want to go to the city center gather. Bus movements, stopping and engine starting operations throughout the day keep the noise level of this area constantly high. In a similar study (de Souza et al., 2020), the highest daytime noise level was recorded as 70-71 dBA. Compared to our findings, this indicates that the noise levels at Osmanbey Campus are noticeably higher, likely due to increased traffic density at the enterence and greater human activity factors in the measured areas. In addition, individual vehicles, especially going towards the hospital, medical school and cafeteria and passing through this area, is another important factor that increases the noise.

Another high Lday value was recorded at Point 3 (72.60 dBA). This point is an intersection where the Faculty of Arts and Sciences, one of the academic centers of the campus, is located and is used intensively by students. In this area where pedestrian and vehicle traffic in the surroundings meet, in addition to the entrances and exits to the faculty buildings, vehicle movement within the campus also creates a significant source of noise. The traffic, which is especially intense at the beginning and end of class hours, causes the noise level to increase significantly. Since the noise at this point is at a level that can affect academic functioning on campus, the noise control measures to be taken here will be of great importance.

Similarly, point 11 stands out as another area that draws attention with 72.30 dBA. This point is located on the main road providing access to the campus hospital, and the source of the noise varies. The frequent use of this point by ambulances, hospital logistics vehicles, and individual visitors leads to constant traffic movement. The increasing patient entry and exit density, as well as personnel traffic in the morning hours, cause the noise level to remain high throughout the day. In addition, the background noise created by hospital logistics operations is also an important part of the noise levels at this point. In a study by Çolakkadıoğlu et al. (2018), it was found that the Balcalı Research Hospital in the study area was exposed to 45–60 dB(A) noise levels throughout the day. Compared to these findings, the noise levels at point 11 on Osmanbey Campus are significantly higher. This difference could be attributed to the higher traffic density and logistics activity near the campus hospital, highlighting the need for urgent noise management strategies in this sensitive area.

Point 1, which functions as the main entrance of the campus, has a medium-high Ld level of 66.50 dBA. This area draws attention as an area where vehicles entering the campus are concentrated. Especially in the morning hours, the slowing down, stopping and accelerating of service vehicles, buses and individual cars during the entrance causes the noise level to increase. As the traffic decreases later in the day, the noise levels in this area decrease relatively, but this point remains active throughout the day due to its function as an entrance area.

Similarly, point 9 offers a medium Ld level of 66.80 dBA. This point draws attention as it is close to the campus lodgings. During the daytime, daily activities, working vehicles and logistics operations around the residence create a moderate level of noise in this area, while generally having a quieter environment. Since the residence area is a resting area for campus residents, keeping these noise levels low is an important requirement in terms of improving the quality of life.

Areas such as point 4 and point 5 have relatively lower levels of noise. For example, point 4 is an area where the Faculty of Agriculture is located and intensive agricultural work is carried out. The noise here can mostly be caused by the occasional agricultural activities. Point 5 is an area close to sports sciences and has a less intense traffic flow with 63.10 dBA. Although the noise level in these areas is lower than the average on campus, this situation offers an advantage that supports the academic and social functions of the environment. Noise levels in different parts of the campus, especially in areas with intense human movement such as student dormitories and social areas, are affected by certain social and functional factors. Point 7 is at the top of these points. This area where the dormitories are located is the departure and arrival point of buses, which are an important part of on-campus transportation. The stopping, departure and maneuvering processes of the buses cause an increase in noise levels. In addition, mass movement during students' entry and exit to the dormitories is an important factor that increases noise levels. However, individual vehicle traffic is limited in this area, and the noise generated by buses and students is generally more pronounced. Similarly, although point 8 offers a quieter noise level, there may be a temporary increase in noise, especially during prayer times and mass events. Although such density increases environmental noise levels, this area is generally quite quiet outside of time. Since point 8 functions as the religious center of the campus, it is natural for density in such areas to increase over time and cause an increase in noise. Point 10 is located at the intersection of important academic and administrative centers of the campus. Being located between the Faculty of Theology, Faculty of Medicine and Dean's Office buildings, this increases the noise levels in this area. The constant movement of vehicles, students and staff entering and exiting the faculty, especially during class hours, determines the noise level of this area. In addition, duty visits to the Dean's Office building and the busy times of the Faculty of Medicine cause the noise levels in the area to increase. Especially during social events and meetings, the intensity of academic and administrative activities in the faculties further increases this noise. The noise in this area can both prevent the efficient conduct of academic activities and negatively affect the general quality of life of campus residents. This intense noise between faculties and administrative buildings should be reduced in order to provide a more peaceful working environment for students and employees. This is especially important for individuals who study or engage in activities that require concentration.

Areas with lower Lday levels are located in quiet areas of the campus. For example, point 6 has one of the lowest values with 62.50 dBA. This area is where the engineering faculty is located and is generally less trafficked. One of the main reasons why the area remains quiet is that it is located at the upper end of the campus and there are not many faculties around it. In addition, the surrounding wooded areas significantly reduce noise by acting as both a visual and acoustic buffer. This quiet environment provides an ideal environment for academic activities and is also quieter than the density in other parts of the campus.

Ld values on campus are directly related to the functions and environmental characteristics of the areas. Areas such as main entrances, transfer points and the hospital have the highest noise levels, while areas such as faculties and the surroundings of the residences remain at lower levels. This analysis provides the basis for the identification and management of noise sources throughout the campus, while also allowing strategic recommendations to be developed to increase acoustic comfort.

3.2 Le noise measurement

Le (19:00-23:00) represents a time period when social and academic activities on campus begin to decrease, but activity still continues. During this time, traffic density decreases, while student and staff activities in social areas continue to have a small impact on noise levels. Figure 5 shows detailed noise levels for the evening hours on the Osmanbey Campus.

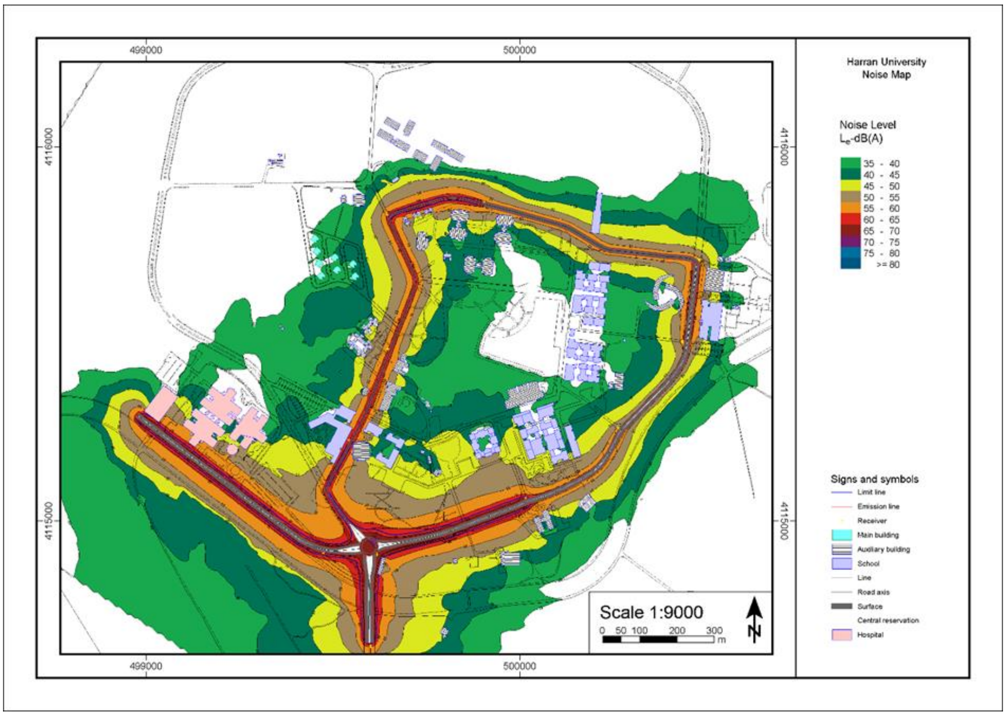

Figure 5. Evening noise levels (Le) across campus

Evening hours are a period when both social and academic activities of the campus continue, but traffic and general mobility begin to decrease compared to daytime hours. The highest Le value was recorded at Point 2 (67.30 dBA). Although noise levels decrease slightly in the evening hours compared to daytime hours (74.90 dBA), the stopping and departure processes of buses keep the noise in this area high. In addition, the exit of personnel buses from the campus during these hours, students waiting at the bus stop and social interactions also contribute to the noise.

Point 11 is another notable point in the evening hours with 66.70 dBA. This area is located on the main route providing access to the hospital and the traffic, which is especially concentrated during the evening work hours, leads to high Le values. This point, where ambulance passages and individual vehicle mobility continue, plays a decisive role in the noise level of the hospital environment. Point 3 stands out as an academic intersection with 66.00 dBA. In the evening hours, the use of this area as both a social meeting point and an area where activities continue after class causes the noise levels to remain relatively high. In particular, the effect of the cafeteria or resting areas around this area is a noticeable noise source in the evening hours.

Point 7 has a moderate Le value of 62.10 dBA. Since this point is an area where student dormitories are located, the activity continues partially in the evening hours. Students entering and exiting the dormitories, campus shuttles and social activities prevent the noise level from completely decreasing in this area in the evening hours. Lower Le values are generally measured in quiet areas. For example, point 6 offers on of the lowest value 56.60 dBA. Point 4 recorded a value of 56.30 dBA, making it quieter zone on the Osmanbey Campus. This point is located near the Faculty of Agriculture, an area characterized by relatively low pedestrian and vehicular activity during evening hours. The agricultural focus of the area, combined with limited evening usage, contributes to the reduced noise levels observed here compared to busier parts of the campus. When compared with a study reporting minimum mean noise levels of 53.61 dBA near an Agriculture Faculty (Özer et al., 2014), a clear similarity is observed. Both locations are situated near faculties with agricultural activities, which tend to experience less human and vehicular traffic, especially during evening hours. While Point 4's noise level is slightly higher, likely due to localized campus dynamics, both areas exhibit lower noise levels compared to other parts of their respective campuses. These findings highlight that agricultural faculties or their surroundings typically offer quieter environments, likely due to their peripheral locations and specialized usage patterns that naturally limit evening activity. This area is generally located between academic units and vehicle and pedestrian traffic decreases significantly in the evening hours. Le values offer a special reflection of the social and academic activity on campus in the evening hours. Areas such as bus stops, hospitals and student dormitories stand out as the main sources of noise during this time period. The existence of quieter areas (such as the engineering faculty area) in the evening hours reveal the diversity within the campus and the change in the noise levels.

3.3 Ln noise measurement

Ln is a time period when the overall activity on campus is at its lowest, but some areas are still exposed to noise. These measurements are particularly important for assessing the tranquility of recreational areas on campus. Figure 6 shows noise levels during night hours, providing a basis for identifying quiet areas and areas requiring improvement.

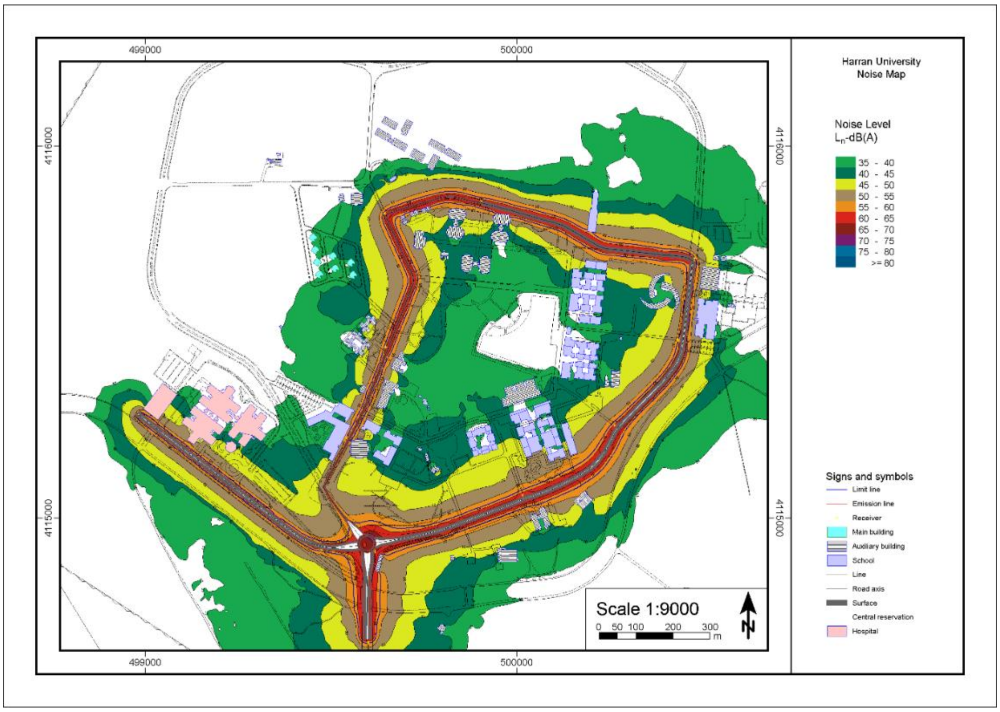

Figure 6. Nighttime noise levels (Ln) across campus

Although noise levels are generally lower throughout the campus at night, some points continue to have a certain noise level throughout the night.

Point 2 shows the highest value on campus in terms of nighttime noise levels, with 64.80 dBA. Buses passing at night, starting and stopping their engines, cause noise levels to remain high at this point throughout the night. In addition, this area is constantly in motion due to being located at a busy access point of the campus. This makes it difficult to provide a peaceful environment for campus residents, especially at night. The persistent traffic activity throughout the night can be an obstacle for students and staff who wish to rest, so reducing noise levels at this point is critical to improving the quality of campus life. A similar situation is reported by Lannace et al (2021) in their study, where areas affected by nightlife generate noise levels between 85 dBA to 90 dBA. This study found that such noise caused significant disturbances for residents, leading to conflicts between patrons, club managers, and residents. The constant movement and noise in these areas created uncomfortable conditions, particularly at night. Similarly, in this study, the high nighttime noise levels at Point 2, combined with continuous traffic and movement, highlight the discomfort noise causes for those seeking peace, particularly during nighttime. These findings underscore the critical need to address nighttime noise pollution to improve the overall living conditions for residents in both urban and campus settings.

While noise levels generally decrease throughout the campus at night, some points maintain a significant noise level due to factors such as human and vehicle traffic. For example, point 3 stands out as a busy academic area even at night with 63.50 dBA. Extracurricular activities, group work and social interactions of students increase the noise in this area. Similarly, point 7 stands out as an area where student dormitories are located with 62.60 dBA. The stops and passages of buses on campus and the movement of students around the dormitories increase the noise levels at this point. Point 4 has a certain noise level with 62.00 dBA due to the low night traffic movement. On the other hand, points 8 and 9 are among the areas with medium noise. These points maintain a certain sound intensity with 60.40 dBA and 60.10 dBA, respectively, due to reasons such as human movement and bus passages at night. Point 11 creates a significant noise source with 58.57 dBA due to ambulance passages and hospital activities continuing throughout the night. Point 6, located near the stadium, has a noise level of 58.90 dBA during the night, which is primarily due to low traffic and student activities. Although the stadium is situated nearby, it was not used for any night activities, and no sports matches took place during the measurement period. This is in contrast to a study by Akintunde et al. (2020), which recorded the highest average noise level of 76.4 dB during the morning hours over a 1-week period at J.T. Useni Stadium. This stark difference highlights how the presence of a stadium, when actively used for events, can significantly elevate local noise levels, far exceeding those observed in this study on the Osmanbey Campus.

Point 5 has the lowest night noise level on campus with 56.40 dBA. The main reason for the quietness of this area is that there is no heavy traffic and active social areas around it. This area, which draws attention with its proximity to the Faculty of Sports Sciences, has a very calm atmosphere at night due to the sports facilities generally used during the day. In addition, the low density of buildings and structures in this area, combined with the natural environment, creates an acoustic buffer zone and ensures that noise levels remain low. The low nighttime activities around the sports fields also make this area one of the most peaceful places on campus.

All Ln measurement points exceeded the highway environmental noise limit value of 55 dBA. This situation makes it difficult to provide a peaceful environment for campus residents, especially at night. Long-term high noise levels at night can negatively affect the sleep quality of students staying in the dormitory and campus security personnel, and harm their physical and mental health. It also carries the risk of decreasing academic success and overall living comfort. Therefore, controlling noise sources and implementing acoustic improvement strategies stand out as a critical necessity to improve the quality of campus life.

4. Conclusion

This study comprehensively analyzes noise pollution levels between various points on the Osmanbey Campus, highlighting the effects of noise exposure over time periods. The findings aim to contribute to a broader understanding of how environmental factors, traffic patterns, human mobility, and campus functions affect the acoustic structure in academic environments.

The importance of weighted noise levels (Ld, Le and Ln) over time in a holistic assessment of acoustic pollution is demonstrated. Differentiating noise levels between daytime, evening and nighttime allowed for a more precise determination of critical noise points. In terms of practical applications, this study highlights the need for targeted noise reduction strategies in areas with high noise exposure. In particular, areas with intense noise such as bus stops, academic centers, and hospital areas should be prioritized for interventions aimed at reducing noise exposure. Among the suggestions that can be developed are encouraging the use of existing bicycles and walking paths within the campus. Providing bicycles and improving the safety of roads to encourage bicycle use. Walking paths can be made more attractive with rest areas and lighting. In addition, electric scooter and bicycle rental systems can be established on campus.

A "green transportation hours" application can be initiated to increase the preference for bicycle and walking paths during busy traffic hours on campus. This application can balance bus and vehicle traffic while encouraging students to use alternative transportation methods. In addition, awards can be offered to students who prefer bicycle and walking paths for transportation. Such incentives can encourage students to adopt environmentally friendly transportation habits, reduce traffic density on campus and reduce noise generation.

The creation of sound barriers or acoustic landscaping in high traffic areas and the creation of quiet zones close to academic and student residential areas are necessary. In addition, noise regulations and better noise planning regarding the organization of evening and nighttime events are important to prevent disruption of campus life.

In addition, continuous monitoring of noise levels is of great importance to evaluate the effectiveness of implemented noise control measures and to adapt according to changes in campus use. Regular evaluations can help identify new trends in noise pollution sources and quickly intervene in possible increases.

In conclusion, by adopting a data-driven approach and implementing recommended measures, it will be possible to create a more comfortable acoustic environment that will support academic success and living comfort in the campus environment.

Declaration of Author Contributions

The authors declare that they have contributed equally to the article. All authors declare that they have seen/read and approved the final version of the article ready for publication.

Declaration of Conflicts of Interest

All authors declare that there is no conflict of interest related to this article.

Acknowledgment

We would like to thank Harran University for allowing us to carry out the measurements on the Osmanbey Campus.

References

Akintunde, E.A., Bayei, J.Y., Akintunde, J.A., 2020. Noise level mapping in University of Jos, Nigeria. *Geo Journal*, 1-13.

Chan, G., Sen, G., Genfeng, Z., 2019. Research on rapid detection and control mechanism of urban traffic noise impact based on Soundplan software simulation. In IOP Conference Series: Earth and Environmental Science, IOP Publishing, No. 5.

Çolakkadıoğlu, D., Yücel, M., 2017. Modeling of Tarsus-Adana-Gaziantep highway-induced noise pollution within the scope of Adana city and estimated the affected population. *Applied Acoustics*, 115: 158-165.

Çolakkadıoğlu, D., Yücel, M., Kahveci, B., Aydınol, Ö., 2018. Determination of noise pollution on university campuses: a case study at Çukurova University campus in Turkey. *Environmental Monitoring and Assessment*, 190: 1-14.

de Souza, T.B., Alberto, K.C., Barbosa, S.A., 2020. Evaluation of noise pollution related to human perception in a university campus in Brazil. *Applied Acoustics*, 157: 107023.

Gilani, T.A., Mir, M.S., 2022. A study on road traffic noise exposure and prevalence of insomnia. *Environmental Science and Pollution Research*, 29(27): 41065-41080.

Goines, L., Hagler, L., 2007. Noise pollution: a modem plague. *Southern Medical Journal*, 100(3): 287-94.

Gong, X., Fenech, B., Blackmore, C., Chen, Y., Rodgers, G., Gulliver, J., Hansell, A.L., 2022. Association between noise annoyance and mental health outcomes: A systematic review and meta-analysis. *International Journal of Environmental Research and Public Health*, 19(5): 2696.

Haron, Z., Han, L.M., Darus, N., Lee, Y.L., Jahya, Z., Hamid, M.F.A., Shek, P.N., 2015. A preliminary study of environmental noise in public university. *Jurnal Teknologi*, 77(16).

Harran University. (2024). Birim içi değerlendirme raporu (BİDR) 2023. (https://ogrenci.harran.edu.tr/assets/uploads/sites/137/files/birim-ici-degerlendirme-raporu-bidr-2023-07022024.pdf), (Accessed: 01.06.2024)

Iannace, G., Trematerra, A., Lombardi, I., 2021. Effects of nightlife noise in a city center. *Noise Mapping*, 8(1): 228-235.

Khan, J., Ketzel, M., Kakosimos, K., Sørensen, M., Jensen, S.S., 2018. Road traffic air and noise pollution exposure assessment–A review of tools and techniques. *Science of the Total Environment*, 634: 661-676.

Kumari, S., Sharma, A., Ghosh, A.K., 2023. Noise pollution and associated health impacts at ganeshpeth bus terminus in Nagpur, India. *Noise Mapping*, 10(1): 20220168.

Lee, S.C., Kim, J.H., Hong, J.Y., 2019. Characterizing perceived aspects of adverse impact of noise on construction managers on construction sites. *Building and Environment*, 152: 17-27.

Ma, J., Li, C., Kwan, M.P., Kou, L., Chai, Y., 2020. Assessing personal noise exposure and its relationship with mental health in Beijing based on individuals' space-time behavior. *Environment International*, 139: 105737.

Natarajan, N., Batts, S., Stankovic, K.M., 2023. Noise-induced hearing loss. *Journal of Clinical Medicine*, 12(6): 2347.

Öngel, A., Sezgin, F., 2017. Trafik gürültüsünü etkileyen faktörlerin soundplan 6.5 programı ile incelenmesi. *Teknik Dergi*, 28(1): 7669-7684.

Özer, S., Zengin, M., Yılmaz, H., 2014. Determination of the noise pollution on university (education) campuses: a case study of Ataturk University, Ekoloji.

Peris, E., 2020. Environmental noise in Europe: 2020. *European Environment Agency*, 104.

Petri, D., Licitra, G., Vigotti, M.A., Fredianelli, L., 2021. Effects of exposure to road, railway, airport and recreational noise on blood pressure and hypertension. *International Journal of Environmental Research and Public Health*, 18(17): 9145.

Rastgeldi Doğan, T., 2019. An investigation of indoor air quality in old and new campus buildings: Harran University. In M. Özyavuz (Ed.), New approaches to spatial planning and design: Planning, design, applications, Berlin, Germany: Peter Lang Verlag, pp. 545–559.

Redman, Y., Vercelli, C., Cantor-Cutiva, L.C., Bottalico, P., 2022. Work-related communicative profile of voice teachers: effects of classroom noise on voice and hearing abilities. *Journal of Voice*, 36(2): 291-e17.

Shukla, A., Tandel, B.N., 2024. Association of road traffic noise exposure and school childrens' cognition: A structural equation model approach. *Environmental Research*, 240: 117388.

Sors, F., Tomé Lourido, D., Parisi, V., Santoro, I., Galmonte, A., Agostini, T., Murgia, M., 2019. Pressing crowd noise impairs the ability of anxious basketball referees to discriminate fouls. *Frontiers in Psychology*, 10: 498770.

Stansfeld, S., Clark, C., Smuk, M., Gallacher, J., Babisch, W., 2021. Road traffic noise, noise sensitivity, noise annoyance, psychological and physical health and mortality. *Environmental Health*, 20: 1-15.

Wang, H., Wu, Z., Chen, J., Chen, L., 2022. Evaluation of road traffic noise exposure considering differential crowd characteristics. *Transportation Research Part D: Transport and Environment*, 105: 103250.

Welch, D., Shepherd, D., Dirks, K.N., Reddy, R., 2023. Health effects of transport noise. *Transport Reviews*, 43(6): 1190-1210.

WKC Technology Ltd. 2024. About us. Retrieved from https://soundplan-uk.com/about-us/ (Accessed: 10.06.2024)

World Health Organization, 2018. Environmental noise guidelines for the European region.

World Health Organization, 2019. Environmental noise guidelines for the European Region. World Health Organization. (https://www.who.int/europe/publications/i/item/9789289053563) (Accessed: 10.06.2024).

To Cite: Rastgeldi Dogan, T., Karakuş, C.B., Suzergoz, A., 2024. Mapping Environmental Noise from Road Transportation Using SoundPLAN: The Case of Harran University Osmanbey Campus. *MAS Journal of Applied Sciences*, 9(4): 1130–1145.
DOI: http://dx.doi.org/10.5281/zenodo.14359242.