

ASSESSMENT OF THE IMPACT OF ROAD TRAFFIC NOISE ON THE URBAN ENVIRONMENT AND POPULATION HEALTH IN GABALA CITY

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Keywords *road traffic noise, environmental noise, urban environment, population health, noise pollution, traffic intensity, Gabala, Azerbaijan*

Summary. Road traffic noise is an increasingly important environmental concern in urban areas, particularly in cities experiencing growth in transport activity and tourism. This study assesses road traffic noise levels in Gabala City, Azerbaijan, and evaluates their potential implications for the urban environment and population health. Field measurements were conducted at selected monitoring points along major urban streets characterized by relatively high traffic intensity. Noise levels were measured using a SVAN 947 sound level meter, with observations focusing primarily on Category III and IV streets. The measured values were evaluated against the noise limits adopted in the study. The results indicate that average road traffic noise levels at most monitoring locations remained within or below the referenced limits; however, during peak traffic periods, noise levels along 28 May, V. Gahramanov, A. Javad, and H. Javid streets and avenues exceeded the reference level by approximately 7–10 dB. Particular attention is given to potentially vulnerable population groups, including children, older adults, and pregnant women. The findings demonstrate the importance of continuous urban noise monitoring, improved roadside green infrastructure, traffic management, and regular technical inspection of vehicles. The study provides an empirical basis for integrating environmental noise considerations into urban and transport planning in Gabala.

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Introduction

The rapid development of transportation infrastructure provides substantial economic and social benefits; however, it is also associated with increasing environmental pressures. Road transport, in particular, affects various components of the urban environment through atmospheric emissions and noise pollution. Unlike many natural environmental processes, anthropogenic impacts may occur rapidly and intensively, potentially exceeding the capacity of ecosystems to recover. The continuous growth of motorized transport therefore represents an important source of environmental pressure in urban areas.

Road vehicles are among the major mobile sources of urban environmental pollution. In addition to atmospheric emissions, increasing traffic volumes contribute substantially to environmental noise. In Azerbaijan, the number of motor vehicles has increased considerably in recent years. According to the statistical information cited in the study, the total number of motor vehicles in the country exceeded 1.95 million by the end of 2025, approximately 85% of which were passenger cars. The vehicle fleet increased by approximately 5.5%, or 94,934 vehicles, within one year. These trends highlight the growing importance of assessing transport-related environmental pressures in Azerbaijani cities.

Road traffic noise is generated by multiple components and processes, including engines, transmission systems, exhaust systems, vehicle horns, and tire–road interaction. Its intensity is additionally influenced by road surface characteristics, topography, vehicle condition, traffic speed and intensity, and the presence of urban vegetation. Consequently, traffic noise represents a complex environmental problem whose spatial and temporal characteristics may vary considerably within the same urban area.

Environmental noise is also relevant to public health. The source material associates prolonged exposure to elevated noise levels with adverse effects on the nervous and cardiovascular systems, chronic fatigue, reduced concentration and memory, and disturbances in rest and recovery. Such effects may be particularly important for vulnerable population groups, including children, older adults, and pregnant women.

Despite growing international attention to environmental noise, the source manuscript identifies a lack of sufficiently detailed research on road traffic noise in Azerbaijan. This research gap is particularly relevant for developing urban and tourism centers where increasing mobility may intensify environmental pressures. Gabala City, located on the southern slopes of the Greater Caucasus, represents an important case because of its tourism potential and relatively intensive road traffic. Accordingly, this study aims to measure and assess road traffic noise at selected locations in Gabala City and evaluate its potential implications for the urban environment and population health.

Literature review

Environmental noise is increasingly recognized as an important urban environmental and public-health concern. Road traffic is one of the principal sources of environmental noise exposure, particularly in densely populated urban areas. According to the World Health Organization (WHO), prolonged exposure to environmental noise is associated with adverse outcomes including annoyance, sleep disturbance, cardiovascular effects, cognitive impairment, and reduced well-being. WHO recommends reducing average road traffic noise exposure below 53 dB Lden and night-time exposure below 45 dB Lnight to minimize adverse health effects (World Health Organization, 2018).

Recent epidemiological evidence further supports the relevance of road traffic noise to population health. A systematic review and dose-response meta-analysis by Fu et al. (2023), incorporating 23 studies, found that each 10 dB increase in road traffic noise exposure was associated with an approximately 2% increase in overall cardiovascular disease risk, with stronger associations reported for some cardiovascular outcomes. More recent systematic evidence has similarly reported positive exposure-response relationships between long-term road traffic noise and myocardial infarction and stroke, reinforcing the importance of incorporating environmental noise into urban health assessments.

The magnitude of traffic noise is influenced by a combination of transport and environmental factors, including traffic volume, vehicle speed and composition, road-surface characteristics, vehicle condition, urban morphology, topography, and the spatial relationship between roads and residential areas. Consequently, effective noise assessment requires not only measurement of sound levels but also consideration of the characteristics of the surrounding urban environment. WHO guidance emphasizes interventions at both the noise source and transmission pathway, including traffic-flow management, appropriate road surfaces, vehicle-related measures, barriers, insulation, and urban planning interventions.

In Azerbaijan, previous research has addressed the environmental impacts of road transportation, including traffic intensity and associated anthropogenic pressures (Aliyev, 2013; Khalilov, 2006). However, the available literature remains limited with respect to instrument-based assessments of road traffic noise in regional urban centers. This research gap is particularly relevant for Gabala, where tourism development and increasing mobility may intensify transport-related environmental pressures. Therefore, field-based assessment of road traffic noise in Gabala provides an opportunity to establish baseline evidence for subsequent environmental monitoring and urban planning.

Materials and methods

Study area

The study was conducted in **Gabala City, Azerbaijan**, located on the southern slopes of the Greater Caucasus. Gabala is characterized by an expanding tourism sector and increasing road traffic activity, making traffic-related environmental noise an important issue for urban environmental assessment. According to the statistical data used in this study, the city covers an area of approximately **9.5 km²** and had a population of **15,319 in 2025**.

To obtain a spatially representative assessment of road traffic noise, monitoring locations were selected along streets characterized by different road categories and traffic conditions. Particular attention was given to **Category III and IV streets**, where relatively intensive traffic was observed. The monitoring network covered different parts of the urban road system in order to identify spatial variations in traffic-generated noise. The spatial distribution of the monitoring points and the corresponding noise-level classes is presented in **Figure 1**.

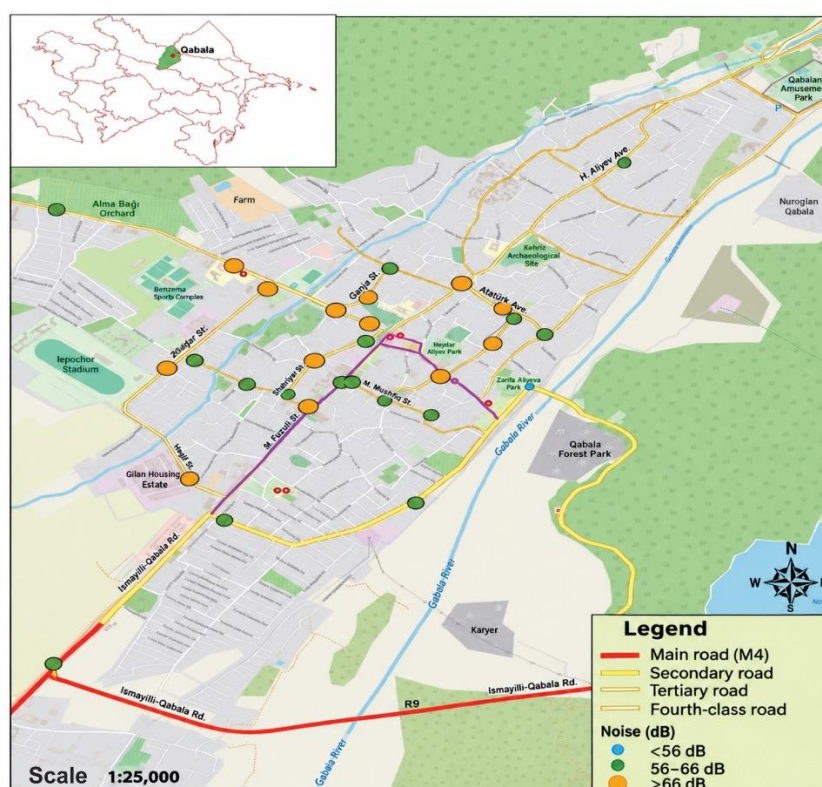


Fig. 1. Spatial distribution of road traffic noise monitoring points and measured noise levels in Gabala City, Azerbaijan

Noise measurement and assessment

Road traffic noise measurements were conducted using a SVAN 947 sound level meter at the selected monitoring locations. The measurements were subsequently processed to characterize the average noise conditions at the investigated sites. More than 36 observation records obtained during the field survey were analyzed to evaluate the spatial variation in road traffic noise across Gabala City.

For spatial interpretation, the measured noise levels were grouped into three classes: <56 dB, 56–66 dB, and >66 dB. These classes were used to visualize the distribution of relatively low, moderate, and high measured noise levels across the urban road network (Figure 1). The classification provides a spatial representation of locations where road traffic noise was comparatively elevated and facilitates comparison among different parts of the city.

The field observations focused on roads with relatively high traffic intensity and considered the influence of road and traffic characteristics on the urban acoustic environment. The resulting measurements were compared across monitoring locations to identify areas where elevated noise levels occurred, particularly during periods of intensive road traffic. The analysis therefore combined instrument-based field measurements and spatial assessment to characterize road traffic noise conditions in Gabala City.

Population-based assessment

To complement the environmental noise assessment, demographic data for Gabala City were examined to identify population groups potentially more sensitive to noise exposure. In 2025, the city had a population of 15,319, comprising 7,565 males (49.4%) and 7,754 females (50.6%). Children aged 0–14 accounted for 3,294 persons (21.5%), the working-age population aged 15–64 comprised 10,646 persons (69.5%), and residents aged 65 years and older accounted for 1,379 persons (9.0%).

These demographic characteristics were considered in interpreting the potential public-health relevance of traffic noise, with particular attention to children and older residents as potentially vulnerable population groups. However, because the study did not include individual-level clinical or epidemiological measurements, the health component was interpreted as an exposure-related assessment rather than evidence of direct causal health effects.

Results and discussion

Road traffic noise can have different effects on human health depending on the intensity and duration of exposure as well as individual susceptibility. The source material indicates that the response to environmental noise may vary according to age, sex, and health status, with children, older adults, and pregnant women considered particularly sensitive groups. It further notes that prolonged exposure to elevated noise levels may affect sleep and contribute to physiological responses involving the cardiovascular and nervous systems.

For a general representation of the relationship between noise intensity and the reported effects considered in the source study, noise levels ranging from 30 to 150 dB are presented in Figure 2.

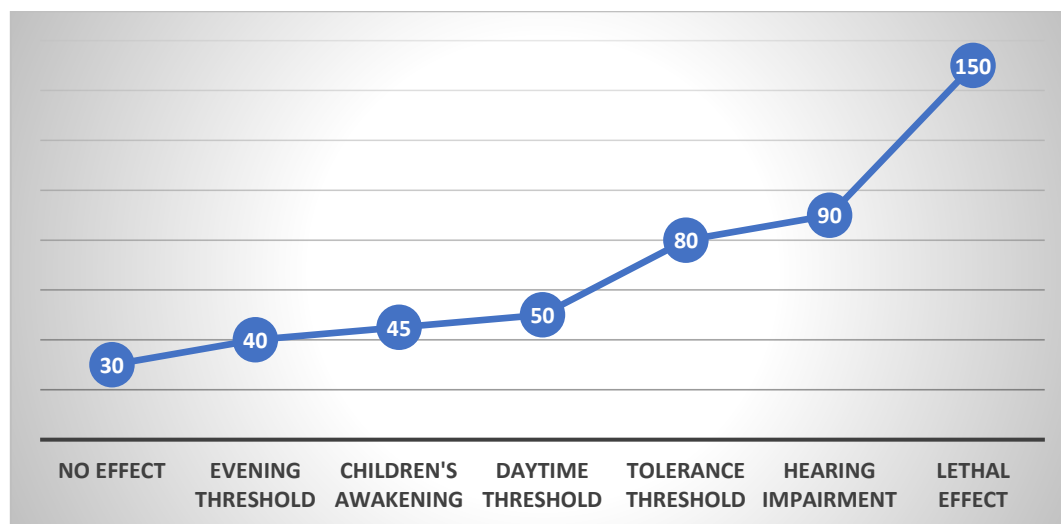


Fig. 2. Noise levels and their reported effects on human health (dB).

The information presented in Figure 2 illustrates that the potential effects associated with noise become progressively more severe as sound intensity increases. However, the health implications of environmental noise cannot be determined solely by a single sound-pressure level, as they also depend on exposure duration, frequency, time of day, individual susceptibility, and other environmental and health-related factors. Therefore, Figure 2 should be interpreted as a general representation of the noise-effect categories considered in the source study rather than as evidence of health outcomes among the population of Gabala.

The field measurements conducted in Gabala demonstrated spatial and temporal differences in road traffic noise levels. Along 28 May Street, V. Gahramanov Street, A. Javad Street, and H. Javid Avenue, average noise levels were generally within the reference range; however, during certain peak traffic periods, the measured values exceeded the reference level by approximately 7–10 dB. In contrast, measurements along 20 January Street, S. Vurgun Street, P. Hashimov Street, and H. Aliyev Avenue were generally at or below the reference level.

These findings demonstrate that road traffic noise is not uniformly distributed throughout Gabala City. Higher noise levels were associated with particular road sections and periods of increased traffic activity. This spatial variation may be influenced by several interacting factors, including traffic intensity and speed, vehicle condition, road-surface characteristics, topography, and the presence of roadside vegetation.

Analysis of more than 36 observation records indicates that the overall road traffic noise environment in Gabala was not characterized by uniformly elevated noise levels during the study period. Nevertheless, the occurrence of values exceeding the reference level during peak traffic periods identifies localized areas where continued environmental noise monitoring may be necessary.

Population exposure and potential health relevance

The demographic structure of Gabala City was also considered when evaluating the potential relevance of environmental noise exposure. In 2025, the city had a total population of 15,319, including 7,565 males (49.4%) and 7,754 females (50.6%). Children aged 0–14 years accounted for 3,294 residents (21.5%), while 10,646 residents (69.5%) were aged 15–64 years and 1,379 (9.0%) were aged 65 years or older.

As shown in Figure 3, females represent 50.6% and males 49.4% of the city's population, indicating a nearly balanced sex distribution. Children aged 0–14 years constitute more than one-fifth of the total population, while residents aged 65 years and older account for 9.0%. These demographic characteristics are relevant to environmental noise assessment because population groups may differ in their susceptibility to noise exposure.

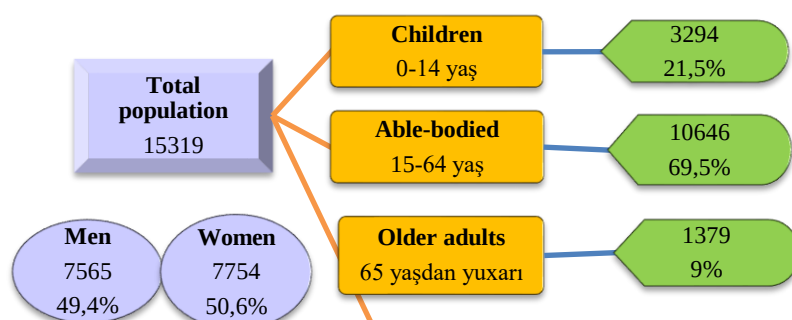


Fig. 3. Age and sex structure of the population of Gabala City in 2025.

However, the present study did not collect individual-level medical data or directly assess associations between measured noise exposure and specific diseases among Gabala residents. Therefore, the findings should be interpreted as an environmental exposure assessment with potential public-health relevance, rather than as evidence of a causal relationship between road traffic noise and health outcomes.

Conclusion

This study assessed road traffic noise in Gabala City, Azerbaijan, using instrument-based field measurements at selected locations representing different road categories and traffic conditions. The findings demonstrate that road traffic noise varies spatially and temporally across the city and is particularly influenced by periods of increased traffic intensity.

The measurements showed that average noise levels at many monitoring locations remained within or below the reference levels applied in the study. However, during peak traffic periods, noise levels along 28 May Street, V. Gahramanov Street, A. Javad Street, and H. Javid Avenue exceeded the reference level by approximately 7–10 dB. In comparison, measurements along 20 January Street, S. Vurgun Street, P. Hashimov Street, and H. Aliyev Avenue were generally within or below the reference range.

The spatial distribution of the measurements indicates that environmental noise in Gabala is characterized by localized traffic-related hotspots rather than uniformly high noise levels throughout the city. Although the observed conditions do not demonstrate direct health effects, elevated noise levels at specific locations may be environmentally relevant, particularly for potentially vulnerable population groups such as children and older residents. Therefore, the results should be interpreted as an assessment of environmental noise exposure rather than as evidence of a causal relationship between traffic noise and specific health outcomes.

Considering the continued development of Gabala as an urban and tourism center, increasing traffic volumes may intensify noise-related environmental pressures in the future. Consequently, systematic monitoring and the integration of environmental noise considerations into urban planning, transport management, and public-health protection strategies are important for maintaining a sustainable urban environment.

Recommendations

Based on the findings, regular road traffic noise monitoring should be conducted at locations characterized by intensive traffic, particularly during peak periods. Priority should be given to areas where elevated noise levels were identified during the field measurements.

Urban and transport planning should incorporate measures aimed at reducing traffic-related noise exposure. These should include the development and maintenance of roadside green belts, improvement of traffic-flow management, regular technical inspection of motor vehicles, and consideration of noise exposure when locating sensitive facilities such as schools and childcare institutions. These measures are consistent with the preventive actions proposed in the original study.

Particular attention should also be given to monitoring areas used frequently by potentially vulnerable population groups. Continued collection of standardized noise data would make it possible to identify long-term trends, evaluate changes associated with increasing traffic intensity, and provide a stronger scientific basis for future environmental and urban-management decisions.

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ОЦЕНКА ВОЗДЕЙСТВИЯ ШУМА АВТОМОБИЛЬНОГО ТРАНСПОРТА НА ГОРОДСКУЮ СРЕДУ И ЗДОРОВЬЕ НАСЕЛЕНИЯ ГОРОДА ГАБАЛЫ

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Резюме. Шум автомобильного транспорта становится всё более значимой экологической проблемой в городских районах, особенно в городах, характеризующихся ростом транспортной активности и развитием туризма. В исследовании оцениваются уровни шума автомобильного транспорта в городе Габала (Азербайджан) и рассматриваются их потенциальные последствия для городской среды и здоровья населения. Полевые измерения проводились в выбранных пунктах мониторинга вдоль основных городских улиц, характеризующихся относительно высокой интенсивностью транспортного движения. Уровни шума измерялись с помощью шумомера SVAN 947, при этом наблюдения были сосредоточены преимущественно на улицах III и IV категорий. Полученные значения оценивались путём сопоставления с предельными уровнями шума, принятыми в исследовании. Результаты показывают, что средние уровни шума автомобильного транспорта в большинстве пунктов мониторинга находились в пределах установленных в исследовании нормативных значений или ниже них. Однако в периоды пиковой транспортной нагрузки уровни шума на улицах и проспектах 28 Мая, В. Гахраманова, А. Джавада и Г. Джавида превышали принятый контрольный уровень приблизительно на 7–10 дБ. Особое внимание уделено потенциально уязвимым группам населения, включая детей, пожилых людей и беременных женщин. Полученные результаты свидетельствуют о важности непрерывного мониторинга городского шума, совершенствования придорожной зелёной инфраструктуры, управления транспортными потоками и регулярного технического осмотра транспортных средств. Исследование формирует эмпирическую основу для учёта экологических аспектов шумового воздействия при городском и транспортном планировании в Габале.

Ключевые слова: автотранспортный шум, экологический шум, городская среда, здоровье населения, шумовое загрязнение, интенсивность движения, Габала, Азербайджан

QƏBƏLƏ ŞƏHƏRİNDƏ AVTONƏQLİYYAT SƏS-KÜYÜNÜN ŞƏHƏR MÜHİTİNƏ VƏ ƏHALİNİN SAĞLAMLIĞINA TƏSİRİNİN QIYMƏTLƏNDİRİLMƏSİ

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Xülasə. Avtomobil nəqliyyatının yaratdığı səs-küy şəhər ərazilərində, xüsusilə nəqliyyat fəaliyyətinin və turizmin inkişaf etdiyi şəhərlərdə getdikcə daha mühüm ekoloji problemə çevrilir. Tədqiqatda Azərbaycanın Qəbələ şəhərində avtomobil nəqliyyatının yaratdığı səs-küy səviyyələri qiymətləndirilmiş və onların şəhər mühitinə və əhalinin sağlamlığına potensial təsirləri araşdırılmışdır. Çöl ölçmələri nəqliyyatın hərəkət intensivliyinin nisbətən yüksək olduğu əsas şəhər küçələri boyunca seçilmiş monitorinq məntəqələrində aparılmışdır. Səs-küy səviyyələri SVAN 947 səs səviyyəsi ölçən cihaz vasitəsilə ölçülmüş, müşahidələr əsasən III və IV kateqoriyalı küçələri əhatə etmişdir. Ölçülmüş göstəricilər tədqiqatda qəbul edilmiş səs-küyün yol verilən hədləri ilə müqayisəli şəkildə qiymətləndirilmişdir. Nəticələr göstərir ki, monitorinq məntəqələrinin əksəriyyətində avtomobil nəqliyyatının yaratdığı orta səs-küy səviyyələri istinad edilən hədlər daxilində və ya onlardan aşağı olmuşdur. Lakin nəqliyyatın pik hərəkət saatlarında 28 May, V. Qəhrəmanov, A. Cavad və H. Cavid küçə və prospektlərində səs-küy səviyyələri istinad göstəricisini təxminən 7–10 dB aşmışdır. Uşaqlar, yaşlı insanlar və hamilə qadınlar da daxil olmaqla, potensial həssas əhali qruplarına xüsusi diqqət yetirilmişdir. Tədqiqatın nəticələri şəhər mühitində səs-küyün davamlı monitorinqinin aparılmasının, yolkənarı yaşıl infrastrukturun təkmilləşdirilməsinin, nəqliyyatın hərəkətinin idarə edilməsinin və nəqliyyat vasitələrinin müntəzəm texniki baxışdan keçirilməsinin əhəmiyyətini göstərir. Tədqiqat Qəbələ şəhərində şəhərsalma və nəqliyyat planlaşdırılması proseslərinə ekoloji səs-küy amilinin inteqrasiyası üçün empirik əsas yaradır.

Açar sözlər: avtonəqliyyat səs-küyü, ətraf mühit səs-küyü, şəhər mühiti, əhalinin sağlamlığı, səs-küy çirklənməsi, nəqliyyat hərəkətinin intensivliyi, Qəbələ, Azərbaycan