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# Determination of Environmental Noise Level of Karasu City Center

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**ABSTRACT**

Noise has become an important environmental problem in the world. Noise maps play a crucial role in city planning and improving the quality of life for both urban residents and natural resources. The study aimed to measure noise levels in 84 different locations within the Karasu municipality (Sakarya, Turkey), including different land uses, which are significant sources of environmental noise. The study was conducted over a 12-month period to create monthly, seasonal, and annual average noise maps. Statistical analysis was performed on the collected noise data and noise maps were generated. The results showed that traffic was the main source of noise and that the highest levels (79,90 dB) were observed on Istanbul and Ankara avenues. The study found that noise levels varied seasonally and that noise levels in many parts of the city exceeded the levels permitted by the Environmental Noise Assessment and Management Regulation in force in Turkey. Three types of noise barriers were proposed for three different selected locations. As a result, there was a significant and positive relationship between the effects of the measured noise levels in all seasons on each other. Another result is in relation to the spatial characteristics of the measurement point, the change in noise level is significant. According to the analysis the changes in noise levels in spring and summer and the spatial differences in the points where measurements were taken are seen at a significant level.

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## INTRODUCTION

Noise pollution has become a major concern globally, with the development of technology, industry, and transportation vehicles, and the increase in population (Morgül and Dal, 2012; Kandemir et al., 2018). Noise is often described as an unpleasant and disturbing sound that can have negative effects on people's health. It is a pollutant that comes after water, soil and air pollution (Erdogan et al., 2014).

It is estimated that the effects of noise on humans begin at levels of 55-60 dB, and that health problems and behavioural disorders begin at levels of 65 dB (Tekalan, 1996). The adverse effects of noise pollution on human health include physiological and psychological disorders, stress, insomnia, irritability, hearing loss, and irregular heart rhythms (Bayramoğlu et al., 2014; Sygna et al., 2014; Clark and Stansfeld, 2007; Babisch, 2008). Scientist Robert Koch said in 1910, "One day, people will have to struggle with noise just like in cholera and plague" (Kalıpcı, 2007).

Some of the noises that affect people in living or working areas originate from within the building and some from outside the building. Environmental noises are examined in two groups depending on the environmental location of the source and receptors and the propagation ways

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of the noise. Indoor sources of noise include music, television, door slamming, crying children, elevators, generator, heating, and cooling systems in the neighborhood. Outdoor sources of noise pollution can be classified into four groups: outdoor environmental noise, transportation noise, industrial noise, building noise (construction), and recreational and commercial noise (Kurra, 2009).

Many domestic and foreign researchers are studying on noise. Kılıç and Abuş (2018), Bayramoğlu (2014), Merchan (2014) conducted studies noise pollution in parks, Urban and Maca (2013) on noise and its effects on people, Yerli et al. (2019), Li et al. (2019), Kavraz (2015), Zannin et al. (2013) on campus noise pollution, Doygun and Doygun (2018) on plant barriers in noise pollution, Taşkaya and Sesli (2018) on noise maps, Kalansuriya (2009), Oden and Bilgin (2019), Kandemir et al. (2018) on traffic transportation noise and conducted on noise maps and alternative solution examples.

Sarker et al. (2023) conducted a study in Rajshahi city (Bangladesh) and measured noise at 22 points in the city. They found that noise levels were higher than the recommended level for both commercial and residential areas.

Tunde and Abdulquadri (2021) conducted a study in Ilorin (Nigeria) and stated that the biggest source of noise was traffic. According to the study, the noise levels measured in commercial and residential areas were found to be above the recommended amount.

Hayward and Helbich (2024) examined noise levels in 9,372 neighbourhoods in the Netherlands, correlating the findings with administrative data on neighbourhood characteristics. Spatial regression analyses were applied to investigate the relationships between noise, demographic and socioeconomic neighbourhood characteristics. They found that 46% of neighbourhoods exhibited noise levels exceeding the 53 dB threshold recommended to prevent adverse health effects.

Pradeep and Shiva Nagendra (2024) investigated the changes in noise levels in different areas of Chennai city. For this purpose, they used mobile monitoring technique during peak and off-peak hours. The measurements were carried out by a moving vehicle along predefined routes covering major roads and traffic junctions. It was found that noise pollution mainly consisted of road traffic and the noise levels exceeded the guideline value of 70 dB(A). The study also revealed that a suburban resident is exposed to high noise levels (74–85 dB(A)) while travelling within the city.

Xu et al. (2022) aimed to measure noise levels across multiple seasons and establish a LUR model to assess the spatial variability of urban noise in Shanghai, China and identify its potential sources. A total of 1296 measurements and 29 predictor variables were used to predict the spatial variation in environmental noise. Factors such as roads, building surfaces, and restaurant clusters were evaluated for the predictor variable that contributed most to the noise level. As a result, a noise prediction map with a resolution of 50 m was produced. Accordingly, it was found that there was a high noise level near traffic arteries in urban areas.

Zheng et al. (2025) aimed to evaluate the environmental noise level of Guangzhou Municipality with land use regression (LUR) models and to create high-resolution daytime and nighttime noise maps. A total of 100 monitoring points were randomly selected according to population density and 800 measurements were made for six months. As a result of the measurements, it was found that the environmental noise in Guangzhou during the day and night exceeded the values recommended by the World Health Organization. It was revealed that the main factors affecting the environmental noise level were traffic-related variables and land use.

The study aimed to investigate the relationship between noise levels and the seasons in the Karasu district center through a year-long measurement. The primary objective was to identify areas where noise levels exceeded the permissible values according to relevant regulations, communiques, and standards. The findings from the noise maps were used to propose solutions for problematic regions and to create zoning plans for the municipality or provide guidelines for renovation works. Many studies that measure noise only show the current noise situation in cities and support it with maps. This study also provides suggestions for solutions, which are much needed in the literature.

## MATERIALS AND METHODS

In the study, the Aziziye, İncili, Kabakoz, Kuzuluk, Yalı and Yeni neighborhoods, located at the borders of the 14.58 km2 development plans of the Karasu Municipality in Sakarya Province (Turkey) constitute the main material of the study. The boundary of the study area is depicted in Figure 1. The noise measurements that form the foundation of the study were

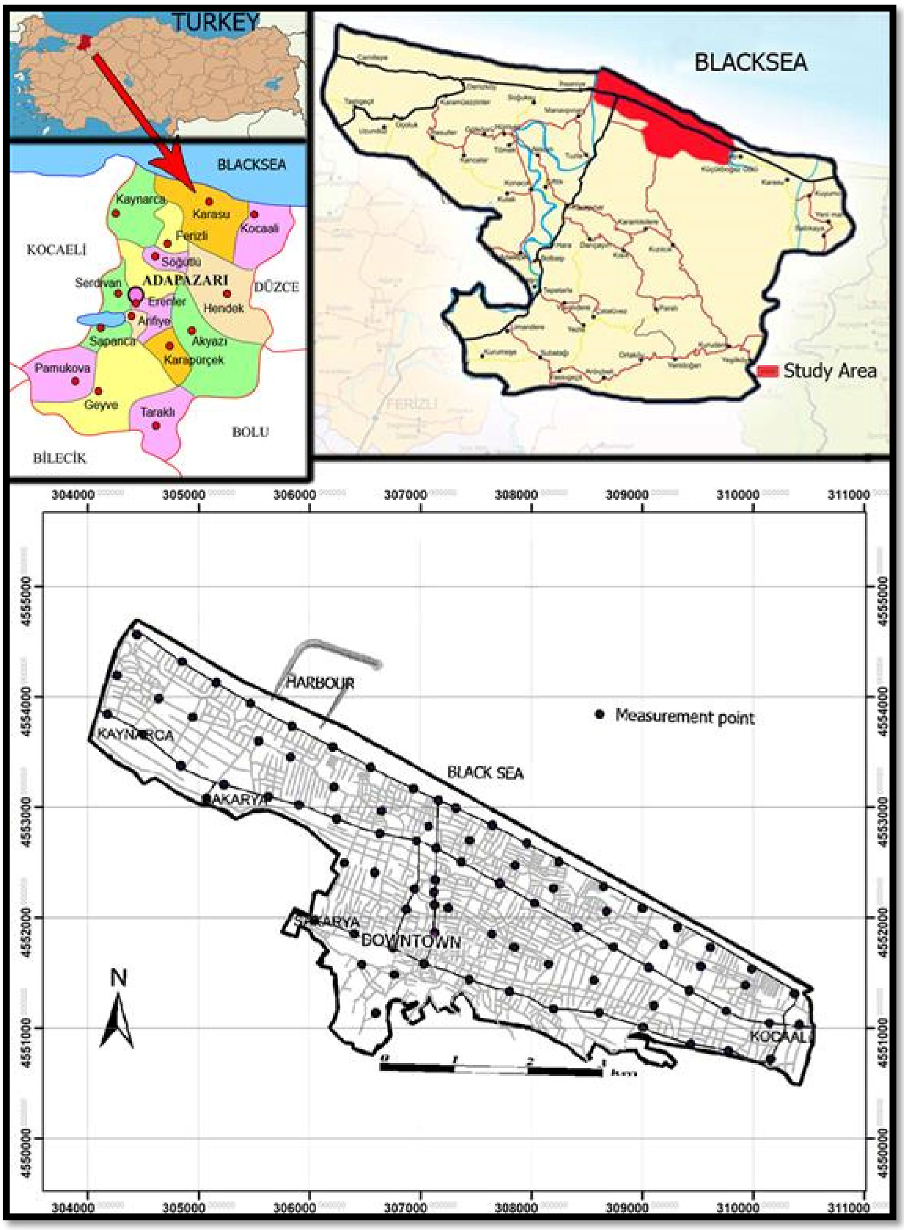


Fig. 1. Location of the study area and the measurement points.

performed using the Svantek 971 model noise measurement device. In this study, the region of Karasu Municipality was chosen for examination, which is a region with various land uses including residential, industrial, commercial, and tourism areas, as well as green spaces. To gather data on noise pollution in the area, a network of 84 measurement points was established along the main highways and transportation routes, which are known to be major sources of environmental noise.

The measurements were taken monthly from March 2019 to February 2020 to provide a comprehensive understanding of the noise levels throughout the year. In accordance with the regulations and standards set forth in the Environmental Noise Assessment and Management Regulation, the equivalent noise levels (Leq) were measured for two minutes at each point, between the hours of 07:00-19:00. According to the Regulation on Assessment and Management of Environmental Noise currently in force in Turkey, the day is divided into 3 time periods: 07:00-19:00 daytime, 19:00-23:00 evening and 23:00-07:00 night time period. This is why in this study, noise measurements were carried out only between 07:00-19:00, which includes the daytime period. This measurement method aligns with the practices used by other researchers in the field, who typically measure noise levels over a period of 1 to 3 minutes (Tang et al., 2020; Filus et al., 2015; Bayramoğlu et al., 2014; Kang and Zhang, 2010).

The Esri ArcGIS software and the interpolation method available in the Spatial Analyst plugin were utilized to create the noise maps. This method has been used in previous scientific studies for creating various maps, such as air pollution maps by Payan and Ertürk (2002), and noise maps by Morova et al. (2010) in Isparta, Aditya et al. (2010) in India, and Tsai et al. (2009) in Taiwan.

For statistical analysis, the SPSS Statistics package program was used to analyze the day and evening noise values of each month, season, and year average. The Paired Samples T Test was applied to compare the means of the noise levels at two different times and to determine if the difference between the means was significant at a certain level of confidence. The results of the analysis are shown in the significance column. If the value here is less than 0.05 (for a 5% significance level), it is interpreted that there is a significant difference between the two paired groups. In addition, correlation analysis was used to measure the degree of impact of the noise levels that changes according to seasons on each other. Correlation analysis indicate the relationship between two (or more) quantitative variables. With this analysis, the scope and strength of the relationship between variables can be measured (Gogtay and Thatte, 2017).

Seasonal noise maps were generated by taking the average of the monthly noise values. This was done to clearly reveal the differences in noise levels, especially in the summer months of the city, and to show the impact of temporary population changes on noise levels.

## RESULTS AND DISCUSSION

### *Seasonal Noise Values in Spring*

As a result of the measurements conducted in the spring season, the lowest noise levels were recorded between the Lighthouse and the Port, with an average of 37.70 dB(A). On the other hand, the highest levels of noise were measured at the entrance of Gümüştaş Concrete Plant on Istanbul Street, with an average of 73.50 dB(A). The noise map of the spring season is presented in Figure 2.

The noise graph of the spring season is given in Figure 3. Considering the statistical analysis between the spring and summer seasons in Table 1, it was seen that there was a significant difference between the values (t:-8.002***p<0.001).

According to the Table 1, there is a significant relationship between the noise levels in spring

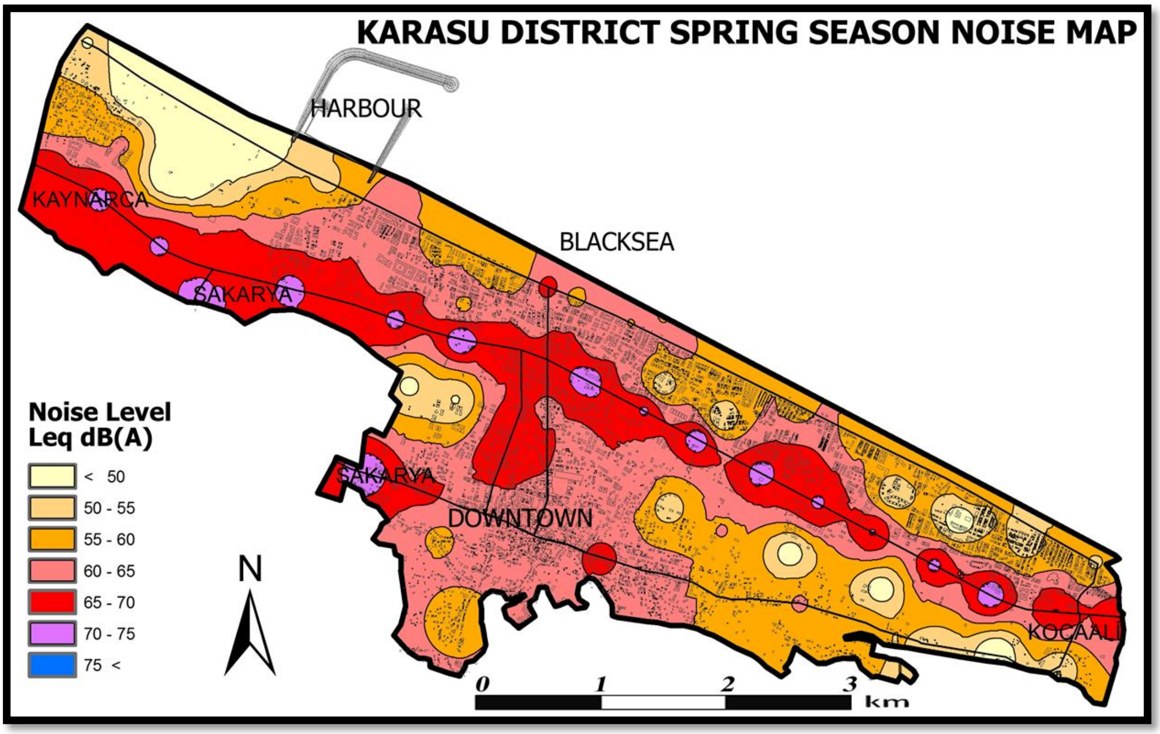


**Fig. 2.** Noise map for the spring season

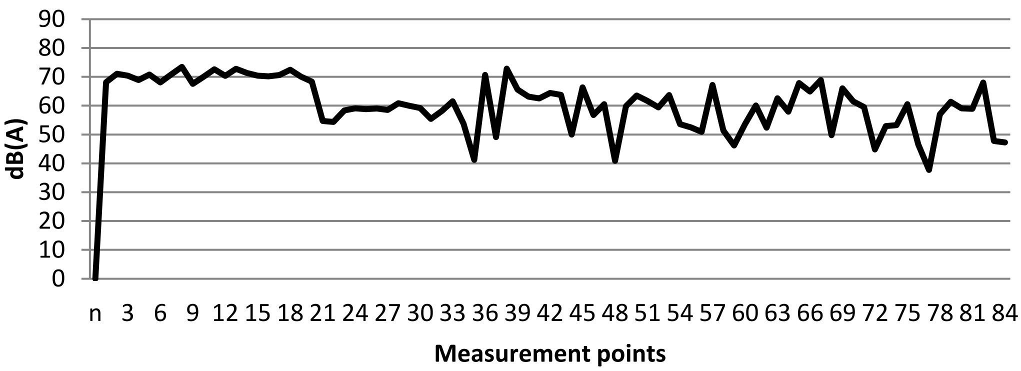


**Fig. 3.** Noise graph for the spring season

**Table 1.** T test for spring – summer noise levels

| Pair | Mean | N | | Mean diff. | t | Sig. |
|---|---|---|---|---|---|---|
| spring | 60,6867 | 84 | spring – summer | -3,18036 | -8,002 | ,000* |
| summer | 63,8670 | 84 | | | | |

*p<0.001

and summer, and it is negative. In other words, summer is louder than spring. It is assumed that this is because outdoor use is longer and more intense in the summer.

*Seasonal Noise Values in Summer*

As a result of the measurements made in the summer season, the lowest values were measured between the Lighthouse and the Port with 45.33 dB(A) and the highest values were measured

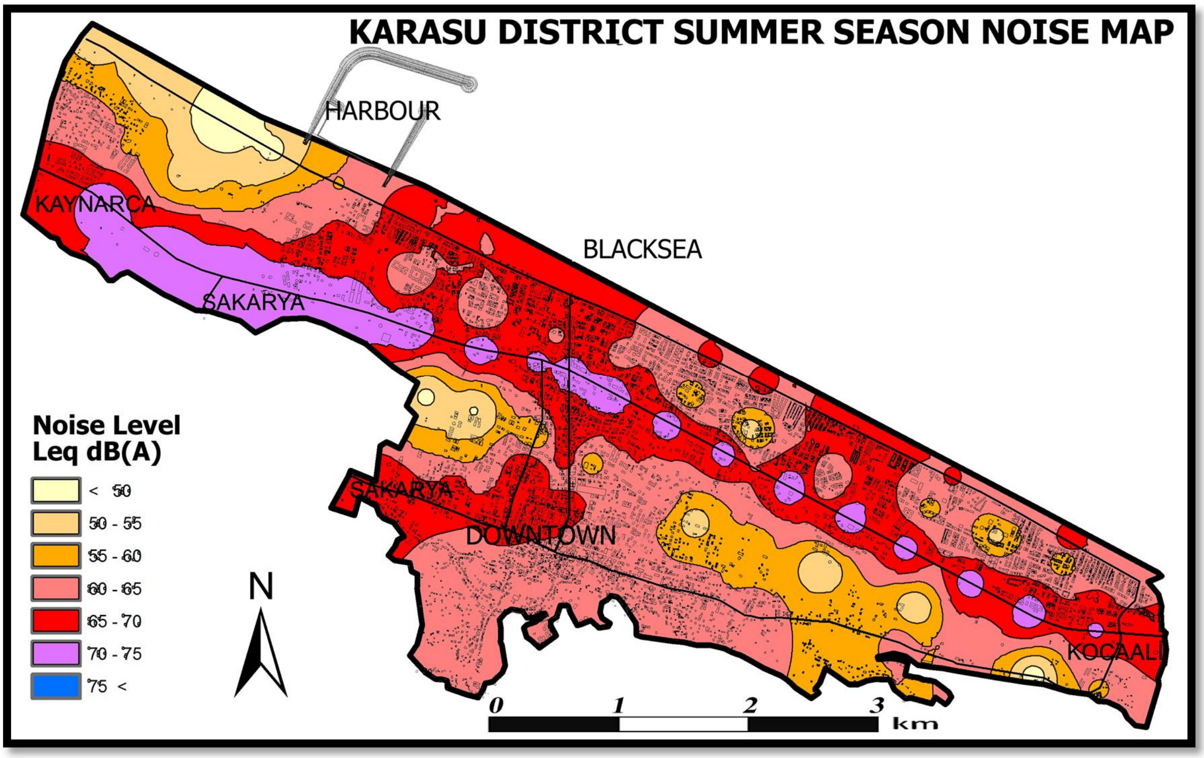


**Fig. 4.** Noise map for the summer season

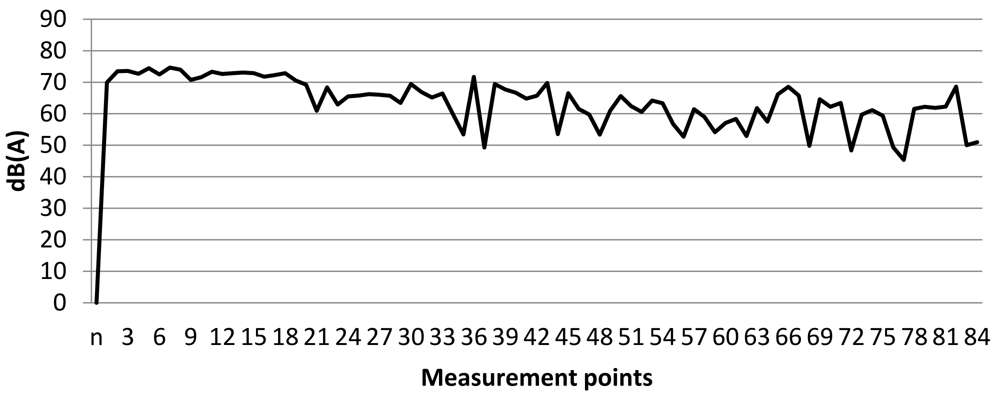


**Fig. 5.** Noise graph for the summer season

**Table 2.** T test for summer - autumn noise levels

| Pair | Mean | N | | Mean diff. | t | Sig. |
|---|---|---|---|---|---|---|
| Summer | 63,8670 | 84 | summer - autumn | 1,79905 | 6,953 | ,000* |
| Autumn | 62,0680 | 84 | | | | |

*p<0.001

with 74.67 dB(A) in front of the Balcı Fırını on the Istanbul street. The noise map of the summer season is shown in Figure 4.

The noise graph of the summer season is given in Figure 5. When the statistical analysis between the summer and autumn seasons is examined in Table 2, it is seen that there is a significant difference between the values (t: 6,953***p<0.001).

According to the Table 2, there is a significant relationship between the noise levels in summer and autumn, and it is positive. In other words, summer is louder than autumn. As with the spring-summer comparison, this is thought to be due to longer and more intensive outdoor use in summer.

*Seasonal Noise Values in Autumn*

As a result of the measurements made in the autumn season, the lowest values were measured between the Lighthouse and the Port with 46.10 dB(A) and the highest values were measured with 74.70 dB(A) in front of Ankara Street, Seferoğlu Car rental. The noise map of the autumn season is shown in Figure 6 and

The noise graph of the autumn season is given in Figure 7.

*Seasonal Noise Values in Winter*

As a result of the measurements made in the winter season, the lowest value was measured between the Lighthouse and the Port with 41.20 dB(A) and the highest values were measured with 73.23 dB(A) in front of the Balcı furnace on the Istanbul Street. The noise map of the

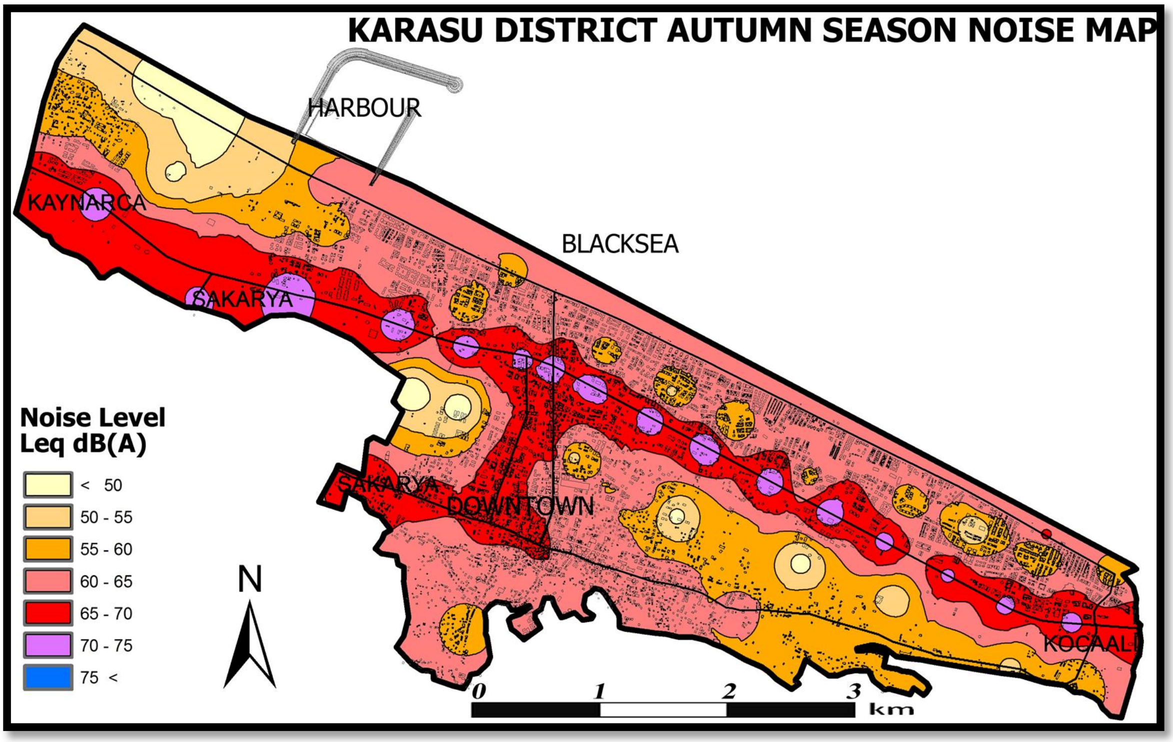


**Fig. 6.** Noise map for the autumn season

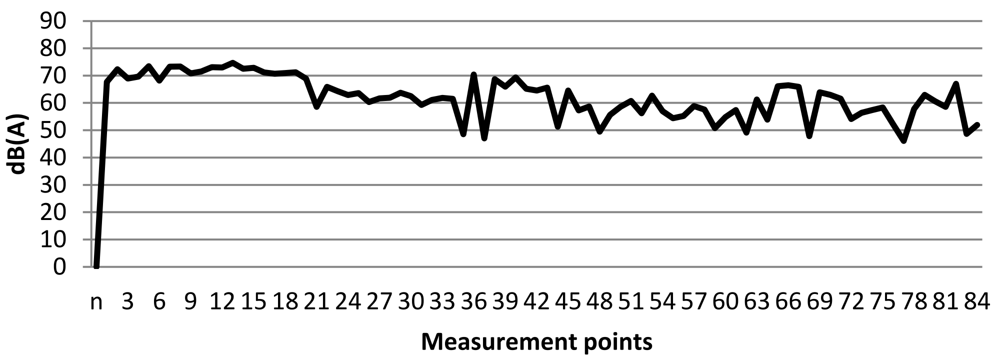


**Fig. 7.** Noise graph for the autumn season

winter season is shown in Figure 8.

The noise graph of the winter season is given in Figure 9. When the statistical analysis between the winter and summer seasons is examined, it is seen that there is a significant difference between the values (t: -8.077***p<0.001).

According to the Table 3, there is a significant relationship between the noise levels in winter and summer, and it is negative. In other words, summer is louder than winter. It is assumed that this is because outdoor use is longer and more intense in the summer.

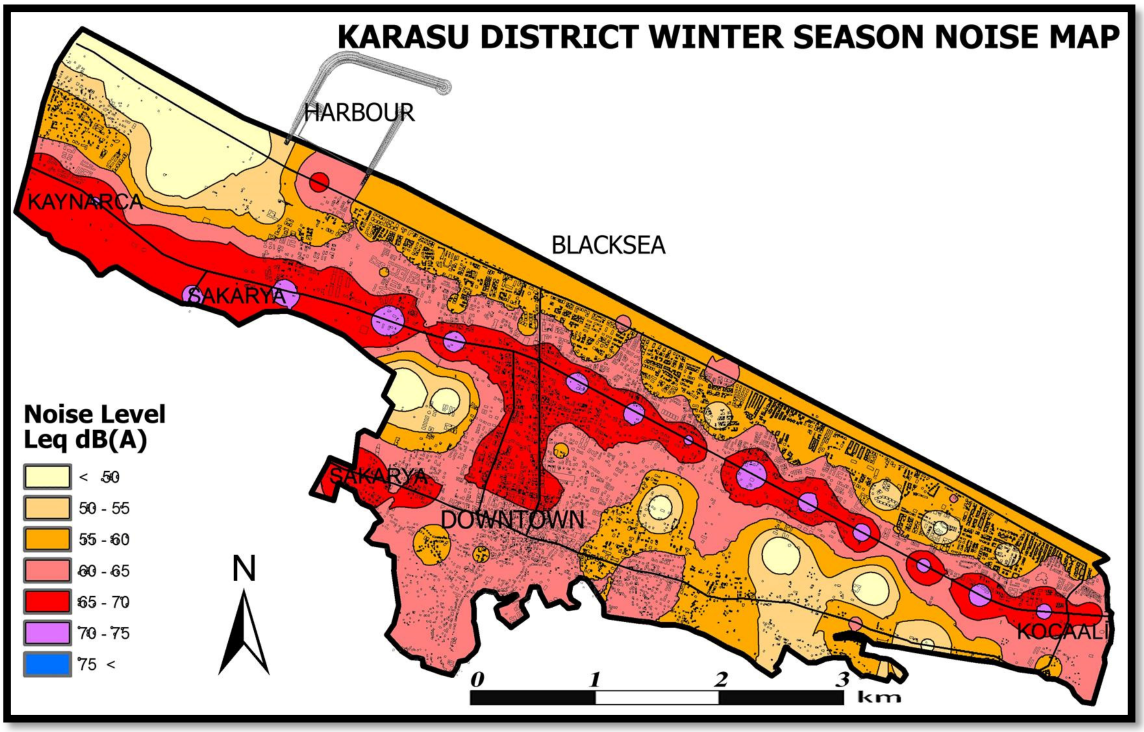


**Fig. 8.** Noise map for the winter season

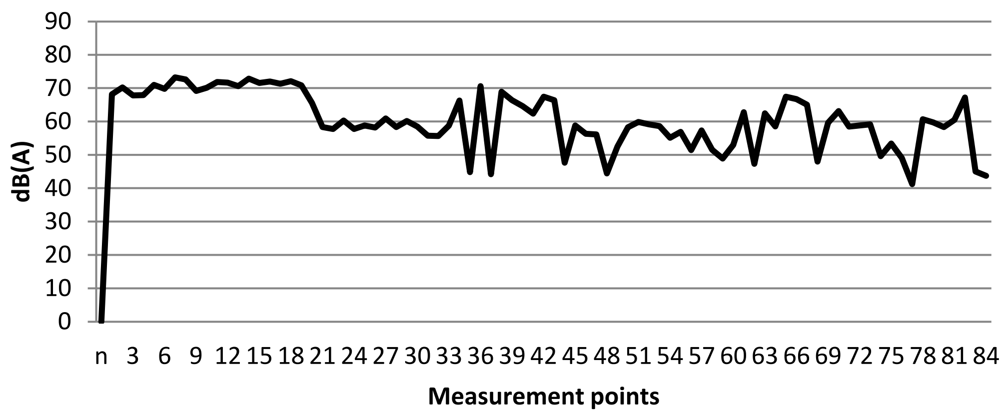


**Fig. 9.** Noise graph for the winter season

**Table 3.** T test for winter – summer noise levels

| Pair | Mean | N | | Mean diff. | t | Sig. |
|---|---|---|---|---|---|---|
| winter | 60,5112 | 84 | winter – summer | -3,35583 | -8,077 | ,000* |
| summer | 63,8670 | 84 | | | | |

*p<0.001

**Table 4.** Statistical analysis of noise variation between seasons

| | Matched Differences | | | | | t | Independence degree | P |
|---|---|---|---|---|---|---|---|---|
| | Mean | Standard deviation | Mean Standard Error | 95% confidence interval of the difference | | | | |
| | | | | Lower | Upper | | | |
| Spring - Summer | -3,18036 | 3,64274 | ,39746 | 3,97088 | -2,38983 | -8,002 | 83 | ,000 |
| Winter - Spring | -,17548 | 3,66863 | ,40028 | -,97162 | ,62067 | -,438 | 83 | ,662 |
| Spring - Autumn | -1,38131 | 3,43000 | ,37424 | -2,12567 | -,63695 | -3,691 | 83 | ,000 |
| Summer - Autumn | 1,79905 | 2,37139 | ,25874 | 1,28442 | 2,31367 | 6,953 | 83 | ,000 |
| Winter - Summer | -3,35583 | 3,80792 | ,41548 | -4,18220 | -2,52946 | -8,077 | 83 | ,000 |
| Winter- Autumn | -1,55679 | 2,89215 | ,31556 | -2,18442 | -,92915 | -4,933 | 83 | ,000 |

**Table 5.** Correlation analysis of noise levels between seasons

| Descriptive Statistics | | | |
|---|---|---|---|
| | Mean | Std. Deviation | N |
| winter | 60,5112 | 8,27116 | 84 |
| spring | 60,6867 | 8,50782 | 84 |
| summer | 63,8670 | 7,26700 | 84 |
| autumn | 62,0680 | 7,41620 | 84 |

| Correlations | | | | | |
|---|---|---|---|---|---|
| | | winter | spring | summer | autumn |
| winter | Pearson Correlation | 1 | ,905** | ,888** | ,938** |
| | Sig. (2-tailed) | | ,000 | ,000 | ,000 |
| | N | 84 | 84 | 84 | 84 |
| spring | Pearson Correlation | ,905** | 1 | ,905** | ,916** |
| | Sig. (2-tailed) | ,000 | | ,000 | ,000 |
| | N | 84 | 84 | 84 | 84 |
| summer | Pearson Correlation | ,888** | ,905** | 1 | ,948** |
| | Sig. (2-tailed) | ,000 | ,000 | | ,000 |
| | N | 84 | 84 | 84 | 84 |
| autumn | Pearson Correlation | ,938** | ,916** | ,948** | 1 |
| | Sig. (2-tailed) | ,000 | ,000 | ,000 | |
| | N | 84 | 84 | 84 | 84 |

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

*Seasonal Noise Difference*

Paired Groups T Test statistical analysis method was applied between binary season groups in order to statistically evaluate the change in noise amount between seasons. Statistical analysis results regarding the values of 84 measurement points are included in the table.

When the seasonal averages are compared with each other, it is seen in Table 4 that the noise differences between the winter and spring seasons cannot be explained statistically. The reason for this is that the values measured in these two seasons are very close to each other. Therefore, no statistically explainable difference was found between them. Apart from this, the noise differences of all seasonal values are explained statistically. When the noise difference between the seasons is examined in the table, it is seen that the highest difference is between Winter-Summer months average -3,35 dB(A) and the least difference is between Spring-Autumn months average -1,38 dB(A). As a result of the analysis in the table, it is seen that the amount of noise differs significantly according to the seasons.

In order to explain the relationship between the change in noise levels and the seasonal differences, the degree to which the noise levels measured in different seasons influenced each other was measured. This was done by correlation analysis. According to Table 5, there was a significant and positive relationship between the effects of the measured noise levels in all

**Table 6.** Regression analysis of noise levels between seasons

Model Summary

| Model | R | R Square | Adjust R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | ,739[a] | ,546 | ,523 | 16,84637 |

a. Predictors: (Constant), autumn, spring, winter, summer

ANOVA[b]

| Model | | Sum of Suuares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 26964,780 | 4 | 6741,195 | 23,753 | ,000[a] |
| | Residual | 22420,220 | 79 | 283,800 | | |
| | Total | 49385,000 | 83 | | | |

a. Predictors: (Constant), autumn, spring, winter, summer
b. Dependent Variable: Measurement points

Coefficients[a]

| Model | | Unstandardized Coefficients | | Standardized Coefficients | | |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | t | Sig. |
| 1 | (Constant) | 205,572 | 16,917 | | 12,152 | ,000 |
| | winter | ,073 | ,686 | ,025 | ,107 | ,915 |
| | spring | 1,659 | ,603 | ,579 | 2,750 | ,007 |
| | summer | -3,108 | ,840 | -,926 | -3,697 | ,000 |
| | autumn | -1,123 | 1,049 | -,342 | -1,071 | ,288 |

a. Dependent Variable: Measurement points

seasons on each other. In other words, an increase in noise levels in one season indicates that an increase in noise levels can be expected in other seasons. The seasons with the strongest potential for noise levels to increase together are summer and autumn, and the weakest are summer and winter.

The results of the regression analysis applied to examine the relationship between seasonal noise levels and spatial differences at the measurement points are presented in Table 6. The dependent variable in the analysis is the measurement points, and the independent variables are the noise levels measured in different seasons. The aim of the analysis is to explain the relationship between the change in noise levels according to the seasons and the measurement points with different urban characteristics. According to the results in Table 6, this model is an important model in explaining the relationship between the change in the amount of noise according to the seasons and the measurement points with different urban characteristics (F: 23.753, $p<0.001$). In this model, the coefficients of the spring and summer noise variables were found to be significant ($p<0.05$), while the autumn and winter noise variables were found to be insignificant ($p>0.05$).

According to the model summary in Table 6, this model has a significant coefficient of determination in explaining the change in noise ($R^2$= 54.6%, $R^2$adj= 52.3%). The significance of the regression model indicates that the correlation is also significant. Therefore, there is a significant relationship between the independent variables included in the model and the dependent variable. The established model is an important model in determining the change in the noise variable and 54.6% of the change (adjusted rate 52.3%) is explained by the independent variables. Therefore, according to the analysis results in Table 6, the relationship between seasonal noise changes and the points where measurements were made at the same time was examined. According to the analysis results in Table 6, the changes in noise levels in spring and summer and the spatial differences in the points where measurements were taken are seen at a significant level, while the changes in noise levels in autumn and winter and the spatial differences in the points where measurements were taken are not seen at a significant level. This is due to the decrease in outdoor use and recreational activities in autumn and winter. According to these results, it was found that the spatial differences in the locations where measurements

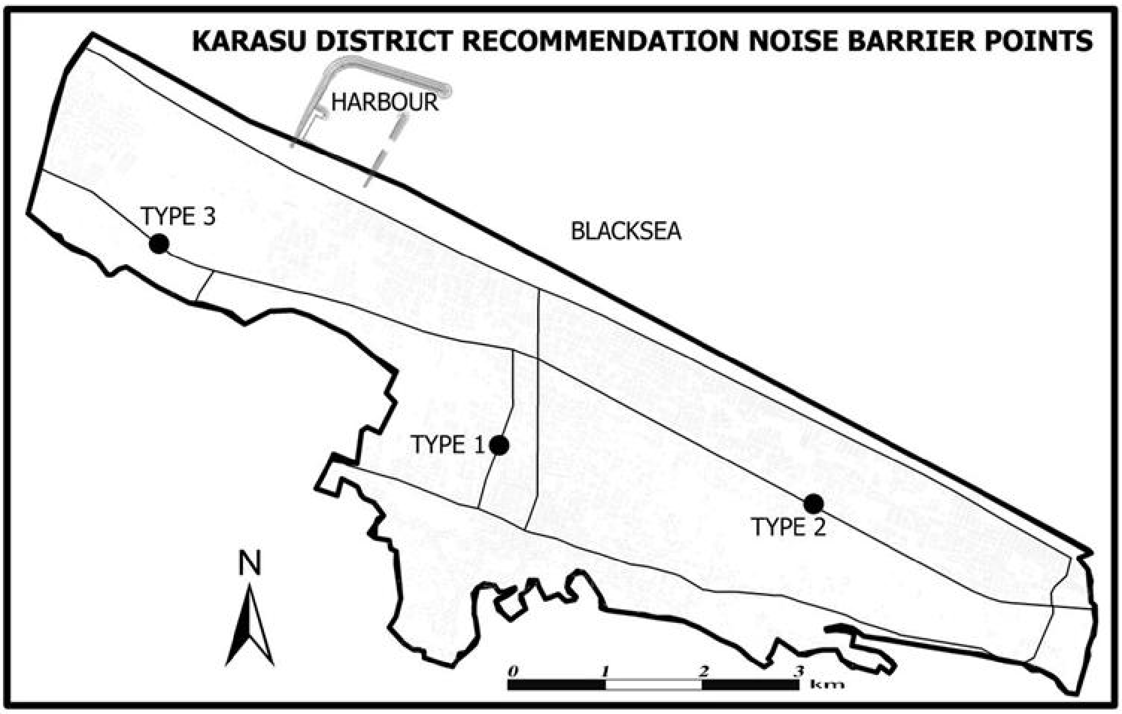


**Fig. 10.** Karasu district recommendation noise barrier points.

were taken in autumn and winter did not have an effect on the change in noise levels, but this relationship could be explained in spring and summer. As the population increases during the summer months due to people coming here on holiday, the late hours of darkness and the favourable climate allow people to stay outdoors for a longer period of time. As a result, in relation to the spatial characteristics of the measurement point, the change in noise level is significant.

The research on noise measurements within the borders of the adjacent area of Karasu Municipality for a year shows that there are significant differences in noise levels in various points of the city center. The analysis of noise maps reveals that the highest noise values are generated around the transportation axes and the main roads, which is mostly due to vehicle traffic. Previous studies by Uslu, Koçer, Arslanoğlu & Hanay (2007) have also found that vehicle traffic is the primary source of noise.

The results of the analysis in Table 4 confirmed the hypothesis that the amount of noise varies between seasons, as also reported by Tsai, Lin & Chen (2009) and Yazgan and Erdoğan (2007) have also found that plant barriers can play an active role in reducing noise.

Fang and Ling (2003) found that a green barrier of large bushes reduced noise by more than 6 dB(A) at a distance of less than 5 meters, while a barrier of trees and bushes reduced noise by 3-5.9 dB(A) at a distance of 6-19 meters and by less than 2.9 dB(A) at a distance of 20 meters. Yazgan and Erdoğan (2007) reported that a 7-row barrier of evergreen plants reduced noise by 6-8 dB(A) compared to a no-plant situation.

To create an effective noise barrier, it is suggested to first use bushes, shrubs, deciduous trees, and coniferous plants and then to use evergreen, hard and broad-leaved, high stature, and frequently branching species (Çepel, 1994).

The study reveals that the noise levels in many parts of the city exceed the permissible values, especially in transportation axes and their surroundings. Based on the characteristics and suitability of the transportation axes and their surroundings, 3 different types of noise barriers have been proposed.

These barrier suggestions are developed for areas where there are suitable areas on the roadside.

• 0-5 meters (Type 1),
• 5-15 meters (Type 2),
• More than 15 meters (Type 3)

Karasu district recommendation noise barrier points are can be seen in Figure 10.

The zones recommended for the “Type 1” distance of 0-5 meters are suggested in the zoning plans for the narrow areas where the parcels are commercially covered by the structures and no shrinkage distance is applied. The quality of the barrier should have the ability to absorb the noise or reflect the noise towards the area where the road is. Plant material should be used on both parts of the barrier. In this way, noise will be absorbed. In addition, an aesthetic and qualified barriers will be obtained by using the plant material, natural and artificial stones used. The relevant proposal barrier is given in Figure 11.

“Type 2” is recommended for areas within 5-15 meters. In this proposal, D010 and D014 highway and side road applications, which are under the responsibility of the General Directorate of Highways, are different from other road types. At the end of the highway, it is aimed to create a natural noise barrier by using dense coniferous trees and bushes. Afterwards, the remaining

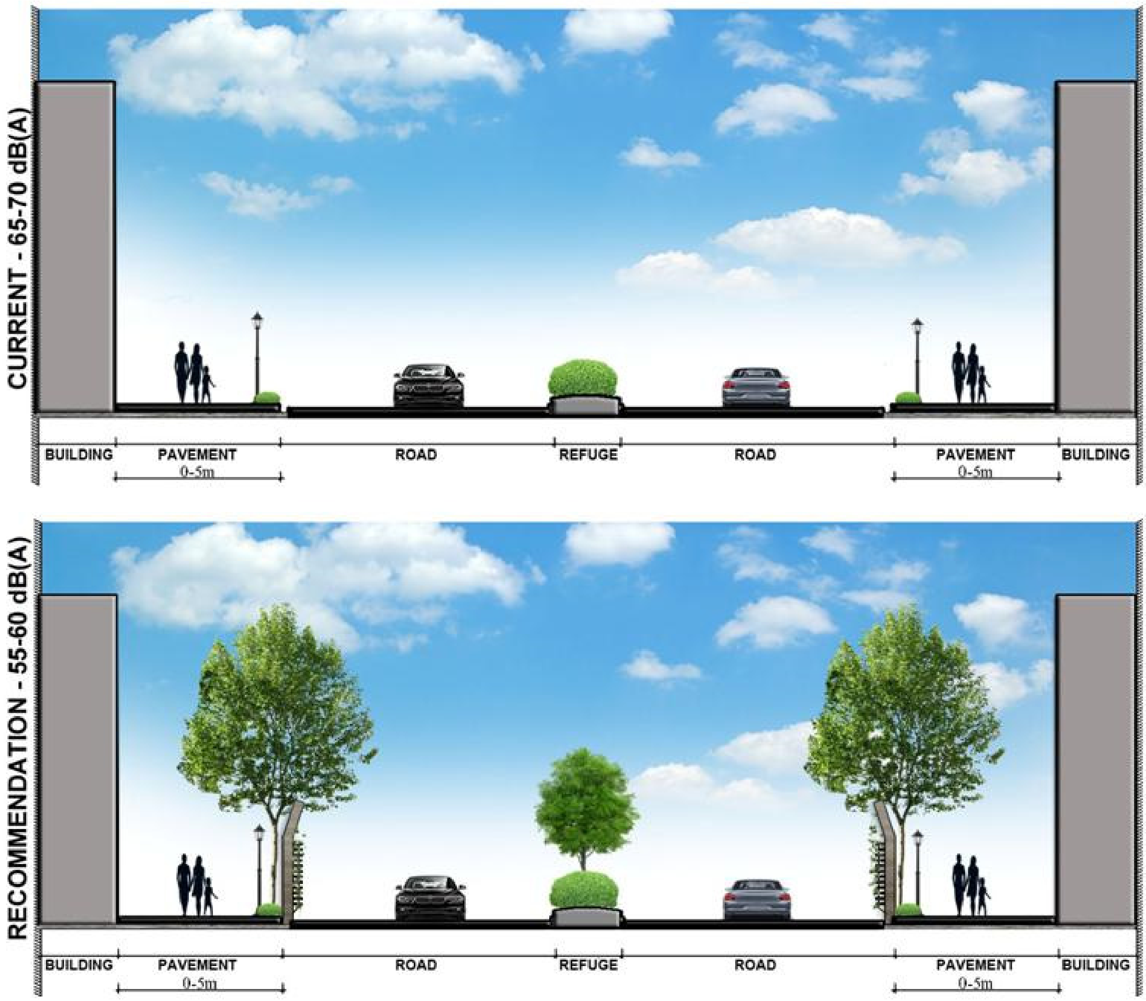


**Fig.11.** Recommended noise barrier for 0-5 meters distance

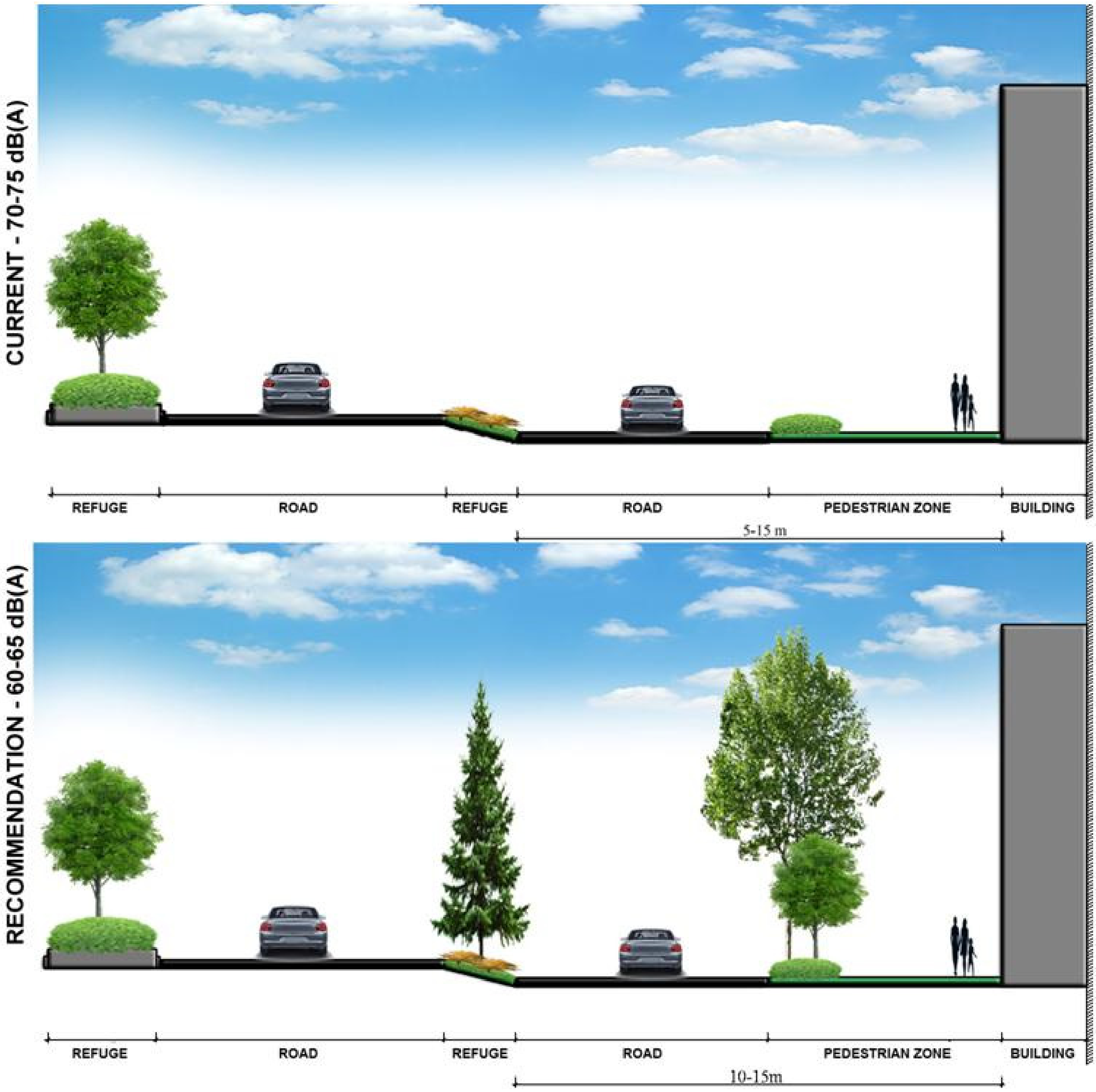


**Fig. 12.** Recommended noise barrier for 5-15 meters distance

distance from the side road application was supported with dense plant species and is given in Figure 12.

"Type 3" is recommended for areas at 15+ meters. Recommended for areas within 15+ meters. It is aimed to create a natural noise barrier in the green area after the completion of the highway. In this part, densely textured coniferous trees, deciduous trees, shrubs and evergreen shrubs were used and is given in Figure 13.

Simulation was used to see the effect of the proposed Type 1, Type 2 and Type 3 noise barriers, constructed according to the characteristics of the transport axes, on the noise exceedance points throughout the study area. The simulation of noise barriers was carried out using the interpolation method in the Spatial Analyst add-on to Esri's ArcGIS software. The simulation was carried out taking into account the noise reduction capabilities of barriers with the characteristics recommended in the literature. In line with the studies conducted, it was predicted that the proposed barriers would reduce noise levels by 5-15 dB(A) compared to the current situation. The annual average noise map of Karasu District and the possible annual noise

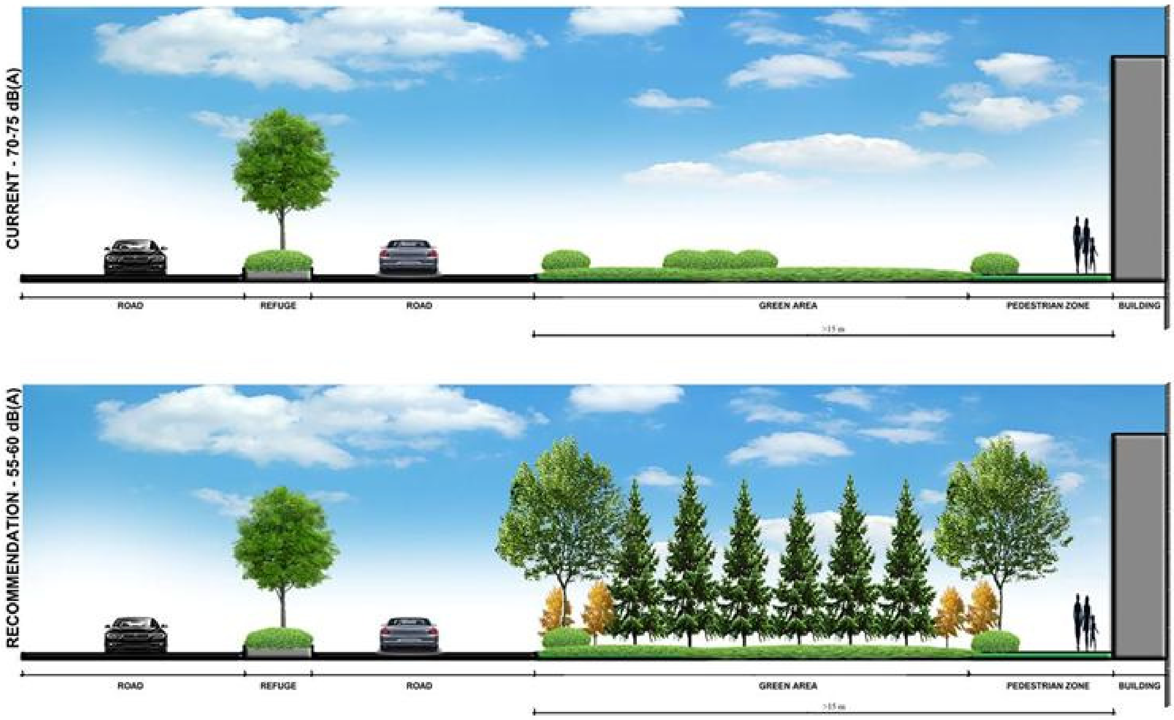


**Fig. 13.** Recommended noise barrier for 15+ meters distance

map that could occur after the proposed noise barriers are shown in Figure 14 for comparison.

The negative effects of noise on human health are explained in the introduction section of the study. According to the values obtained from 84 points throughout the year in the city of Karasu, the amount of noise exceeds the limits allowed by the Regulation on the Assessment and Management of Environmental Noise in force in Turkey at many points. According to the regulation, the permissible limits during the day (between 7 a.m. and 7 p.m.) are as follows 60 dB(A) for existing roads in educational, cultural and health areas, 65 dB(A) for repaired roads; 63 dB(A) for existing roads in residential areas, 68 dB(A) for repaired roads; 65 dB(A) for existing roads in areas with dense commercial structures, 70 dB(A) for repaired roads. There are various methods to reduce the amount of noise at the source, at the receiver, and between the source and receiver. Many factors, from vehicle roads to building facade coatings, are effective in the amount of noise. In addition to these, it is anticipated that the noise amounts can be reduced to values compatible with the limits by applying the 3 types of suggested noise curtains, which include planted and structural materials, at appropriate points in the city.

In addition to all these results, the study of the economic consequences of noise pollution will add value to this and similar studies. The main purpose of this study was not to determine the environmental costs of noise control methods. However, the results obtained provide some basic data for future studies on this subject. The amount of noise in a region and the population are considered to be the two main factors in determining the environmental costs of noise control methods. Amini et al. (2024) in their study found the environmental cost of noise control to be 56,271,911 Euros for a total of 22 regions with different noise levels in the city of Tehran. As seen in this study, the fact that the costs are quite high shows that politicians and decision makers at local and global levels should be sensitive to this issue.

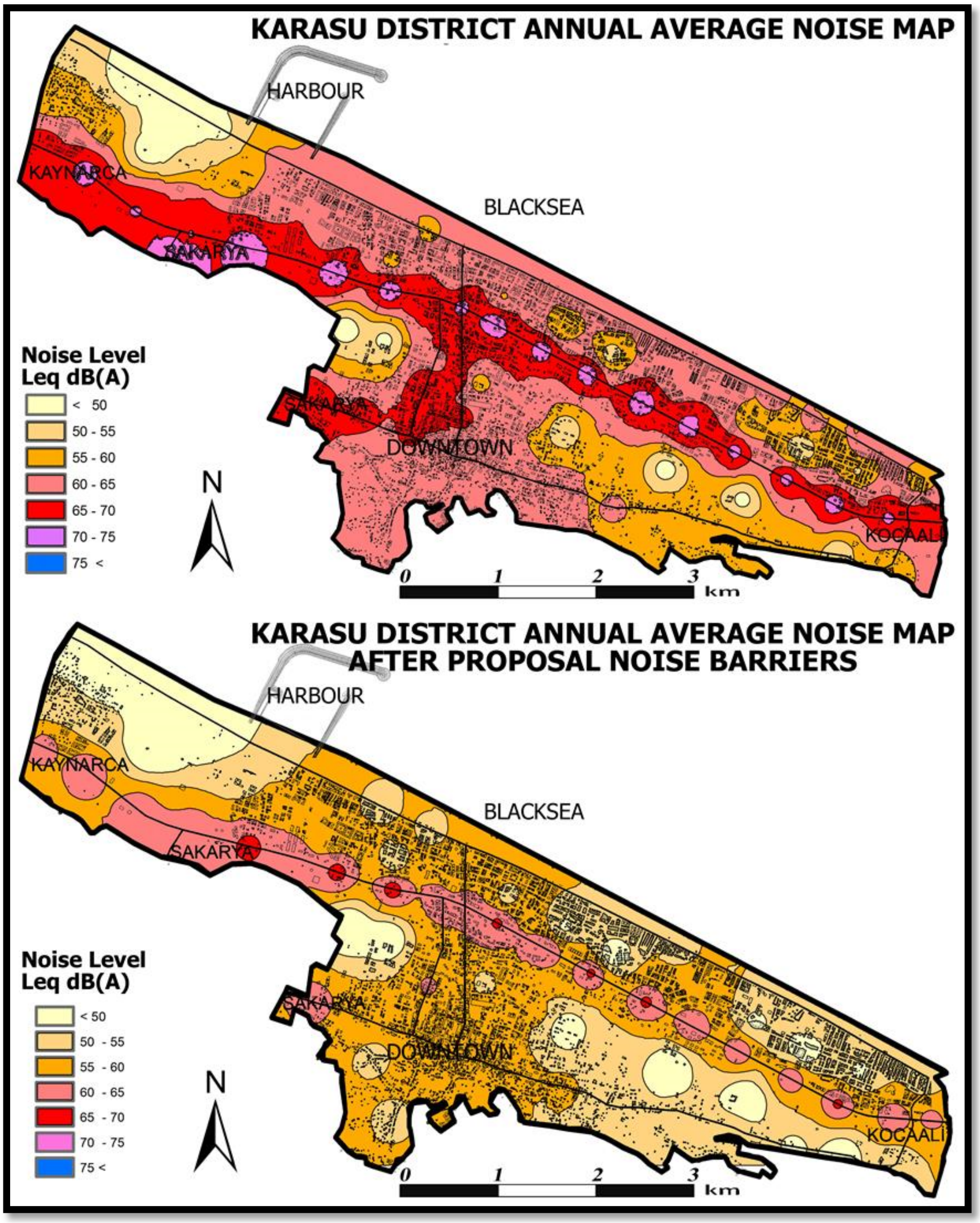


**Fig. 14.** Karasu city annual noise map and possible annual noise map after suggested noise barriers

## CONCLUSIONS

According to the results of the noise measurements within the scope of the research, it was observed that the limits allowed by the Environmental Noise Assessment and Management Regulation in force in Turkey were exceeded at many points in Karasu City center. It was observed that the highest noise values were formed around transportation axes. The main transportation networks within the city are the areas where the noise was measured the most. As a result, it is revealed that the main source of noise is caused by vehicle traffic.

A direct relationship was observed between transportation density and the amount of noise. The areas with the lowest noise values are the areas where the transportation network and building density are low or non-existent. When the noise maps were examined, it was observed that the biggest reason for the noise difference in the northern part of the area was the daily and temporary population and entertainment centers in the summer months. According to the results of the study, it was seen that the summer season values were approximately 5-10 dB(A) higher than the winter season. As a result of the analyses made on the noise values, the month with the highest noise values in the city is July.

It is seen that noise can be reduced by 10-15 dB(A) throughout the city with the data obtained from the literature and the simulation of suggested noise barriers.

As a result, there was a significant and positive relationship between the effects of the measured noise levels in all seasons on each other. Another result is in relation to the spatial characteristics of the measurement point, the change in noise level is significant. According to the analysis the changes in noise levels in spring and summer and the spatial differences in the points where measurements were taken are seen at a significant level.

A similar study has not been conducted in Karasu District before. Therefore, it is an original study for the area. The results of this study will be used to guide planning studies, combat noise pollution and provide a basis for decision-making.

As a continuation of this study, it will add value to the literature to carry out noise measurements in the evening and night time and to investigate the relationship between the data obtained and different land uses.

In addition, the environmental costs of noise control methods are a very sensitive issue. However, the efforts of researchers alone are not enough, decision-makers also have an imtortant role to play. An approach should be taken from the local to the global. This approach should not only emphasise the seriousness of the problem, but also provide practical and economically viable strategies for effective management of urban noise.

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## CONFLICT OF INTEREST

The authors declare that there is not any conflict of interests regarding the publication of this manuscript. In addition, the ethical issues, including plagiarism, informed consent, misconduct, data fabrication and/ or falsification, double publication and/or submission, and redundancy has been completely observed by the authors.

## LIFE SCIENCE REPORTING

No life science threat was practiced in this research.

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