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Environmental Awareness Evaluation within the Scope of Noise Pollution: The Case of Adana-Çukurova District

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ABSTRACT

Today, environmental issues are rapidly increasing due to the growing population, rapid and unplanned urbanization, industrialization pressure, and advancing technology. Consequently, there is an accelerated search for solutions to environmental problems. As in the formation of these problems, humans will be a key factor in solving them. Therefore, individuals need to be developed and equipped in terms of environmental awareness, environmental consciousness, and environmental sensitivity. Many studies in the literature advocate the necessity of education to increase environmental awareness; however, first and foremost, individuals' environmental awareness must be identified and their levels must be revealed. In this study, noise pollution, which has been increasingly impactful in the last 30 years and is ranked as the second-highest burden of disease by the World Health Organization after air pollution, with less awareness compared to other environmental issues, is evaluated. In this context, the research area is selected as the Çukurova District of Adana Province, and the awareness of noise pollution among the residents in the region is assessed through survey forms and SPSS software. Additionally, using the survey results, the proportional values of noise pollution as the most significant environmental issue are evaluated as spatial analysis and mapped.

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Introduction

Informing individuals and increasing the level of environmental consciousness or enhancing environmental awareness play a crucial role in preventing environmental problems (Taycı, 2009). Environmental consciousness is fundamentally defined as understanding the importance of not causing harm to the environment and utilizing it at a sustainable level (Yücel et al., 2006; Mansuroğlu et al., 2010). In other definitions, environmental consciousness is described as raising sensitivity regarding the use and preservation of the natural environment (Başal, 2003), supporting living in a balanced and healthy environment, and serving as an indicator of changes in human attitudes and behaviors in the face of environmental problems (Çolakoğlu, 2010). According to Erten (2005), the aim of environmental consciousness includes environmental knowledge, positive attitudes towards the environment, and behaviors beneficial to the environment. However, it cannot be asserted that the level of internalizing environmental consciousness is the same in all individuals within society; there may be variations in the degree to which individuals internalize environmental consciousness (Karataş, 2013).

As understood from the definitions, the development of individual responses to prevent or reduce environmental problems and the formation of a consistent environmental attitude among all individuals are necessary. For this purpose, the development of environmental consciousness and, consequently, awareness is essential.

In today's world, people and their surroundings are confronted with numerous environmental issues due to factors such as intensive and unplanned industrialization, population growth, rapid and unplanned urbanization, technological advancements, various methods of energy production, new inputs in agriculture, transportation facilities, vehicles, and networks (Yücel, 2000). The increasing connection between environmental problems threatening natural life, humanity, and living environments and their significant impact on the quality of human life has led to a rise in societal environmental sensitivity, environmental conservation awareness, and awareness of environmental issues.

When considering environmental issues that are easier to analyze and visually perceive, such as soil, water, and air pollution, noise stands out as a environmental problem that is more challenging to perceive, dependent on the ongoing process, and relatively new in terms of awareness compared to other environmental issues. Noise, which arises due to factors such as unplanned urbanization, transportation, and industrialization in the process of urbanization, is defined as a type of technological residue (Kurra, 2009; Basner et al., 2014; Onay, 2021).

Environmental noise sources can be categorized as transportation, industry, construction, and entertainment and commercial noises resulting from human activities (Akça, 2009; Kurra, 2009). When evaluating noise sources, as seen in Table 1, the most impactful noise source on individuals in a residential area is traffic noise from highways (Fan et al., 2010; Paşaoğlu, 2013).

Table 1. Impact rates of human and the environment based on noise sources (MEB, 2011)

Noise Sources	Impact Rate (%)
Road traffic	50.0
Rail systems	18.0
Aircraft	13.0
Industry	6.0
Neighbors	3.5
Construction	3.0
Outdoor	2.5
Other sources	4.0

When considering all types of noise sources, there are three main approaches to combat noise, aiming to reduce or prevent it: controlling noise at the source, controlling noise in the area between the source and the receiver (environment), and controlling noise in the receiver, the individual exposed to the noise (user) (Beranek, 1983; Şahin, 2003). For these noise control methods to achieve their goals, it is essential for society to have awareness of noise pollution.

The success of efforts to minimize or even eliminate environmental problems depends not only on a global and political scale but also on fulfilling the necessary responsibilities at the societal level and fostering societal awareness (Erkal et al., 2011; Tunç et al., 2012). Effective planning for environmental protection can only succeed when the public is sensitive to environmental issues. Enhancing environmental sensitivity will contribute to people living in a healthier and safer environment (Özmen et al., 2005; Yeşil and Turan, 2020).

As evident in the resolution of environmental problems, the fundamental aspect in reducing and/or preventing noise pollution is the identification of individuals' awareness and consciousness of noise pollution, as well as fostering the development of this awareness. Various approaches, including surveys, assessments, and scale development, have been evaluated in the literature to assess environmental sensitivity and the public's awareness of environmental issues (Şama, 2003; Yücel et al., 2006; Oğuz et al., 2011; Yeşilyurt et al., 2013; Yeşil and Turan, 2020).

In this study, the survey assessment method is employed to evaluate individuals' knowledge about noise pollution, the level of impact, proposed solutions against noise, and consequently, their awareness. Considering environmental issues, the urban center of Çukurova District in Adana Province, identified as the area most affected by noise pollution, was selected as the research area. The social, demographic, and economic structure of the individuals living in the research area was determined, and the effects of noise pollution were evaluated in terms of perception, knowledge level, experience, opinions, and proposed solutions to mitigate noise pollution as an environmental problem. Additionally, individuals' assessments of noise pollution in the context of environmental issues were analyzed proportionally and spatially, and the distribution was mapped.

Material and Method

Material

According to the 'Turkey Environmental Issues and Priority Assessment Report' prepared by the former Ministry of Environment and Urbanization in 2019, the primary environmental issue in Adana Province is noise pollution. In recent years, Adana Province, particularly Çukurova District, has rapidly developed both vertically and horizontally, transforming into a densely populated urban area. Moreover, due to its possession of dual-directional, 3-4 lane boulevard-like urban roads and its proximity to the TAG highway, the region is highly exposed to traffic-related noise pollution (Bozkurt, 2013; Yücel et al., 2015; Kahveci, 2016; Çolakkadıoğlu and Yücel, 2017). Noise measurements were conducted at the points indicated in Figure 1 to assess the presence of noise pollution in the research area. The measurements were evaluated within the limits defined by the 'Environmental Noise Assessment and Management Regulation' dated June 4, 2010 (Table 2).

When evaluating Table 2, it is observed that the Leq values obtained from all measurement points exceed the limit values, indicating noise pollution originating from the highway.

For all these reasons, the main material of the study consists of the central urban area of Çukurova District in Adana Province. As depicted in Figure 2, nine neighborhoods with the highest residential and transportation density in the city center were included in the research. According to the data from TUIK (2020), the population of Çukurova District is 386,684, while the total population of the 9 neighborhoods comprising the research area is approximately 363,898, accounting for about 95% of Çukurova District's population.

The other materials of the study include a questionnaire consisting of 27 questions. The IBM-SPSS Statistics 26.0 software, which provides opportunities for statistical analysis, was used in the evaluation of the questionnaire.

Furthermore, due to the large scope of the study, the ongoing pandemic, and the need for more accurate and reliable results, professional support was sought during the implementation of the questionnaire. In this context, support was obtained from 'Ayna Public Relations and Research Center,' which provides services in areas such as policy, social, scientific, and consumer domains.

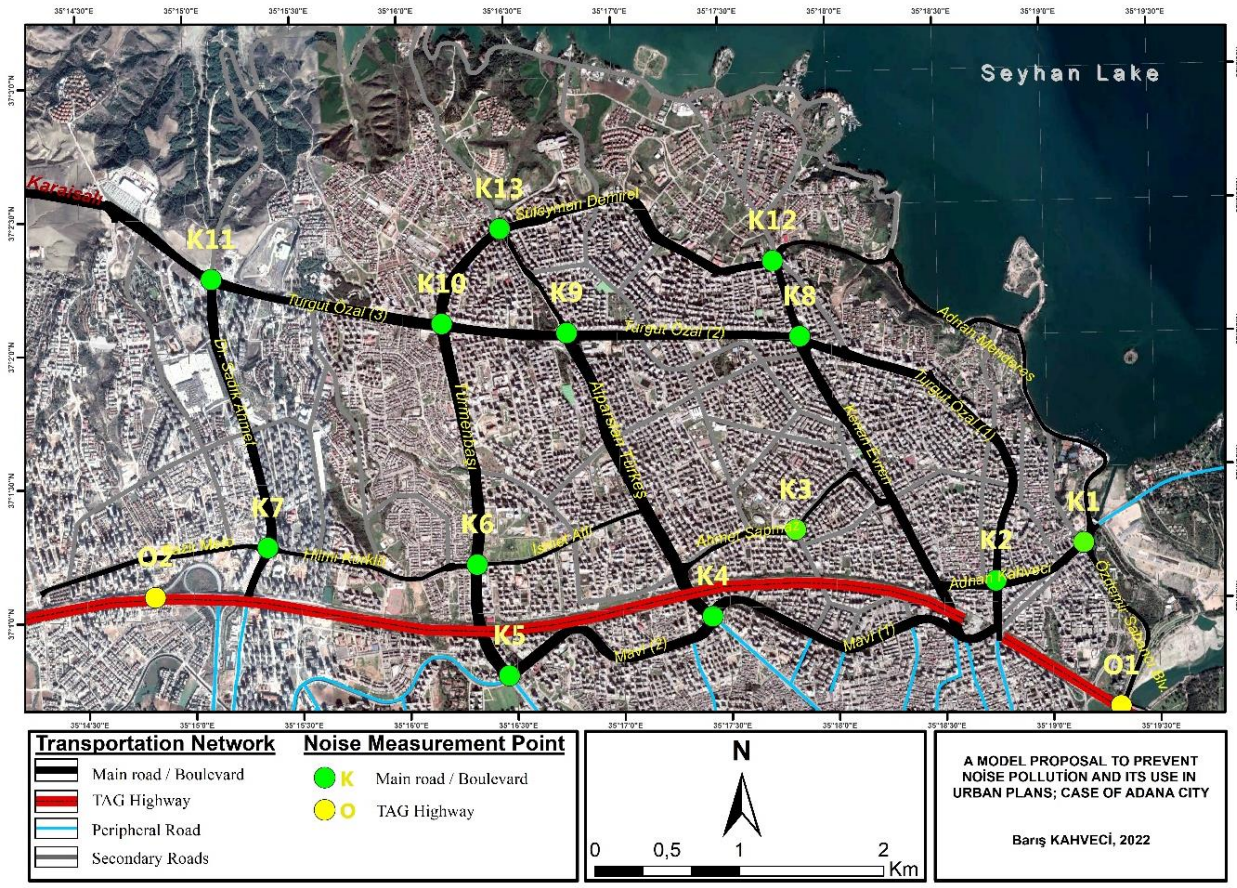

Figure 1. Noise measurement points in the research area

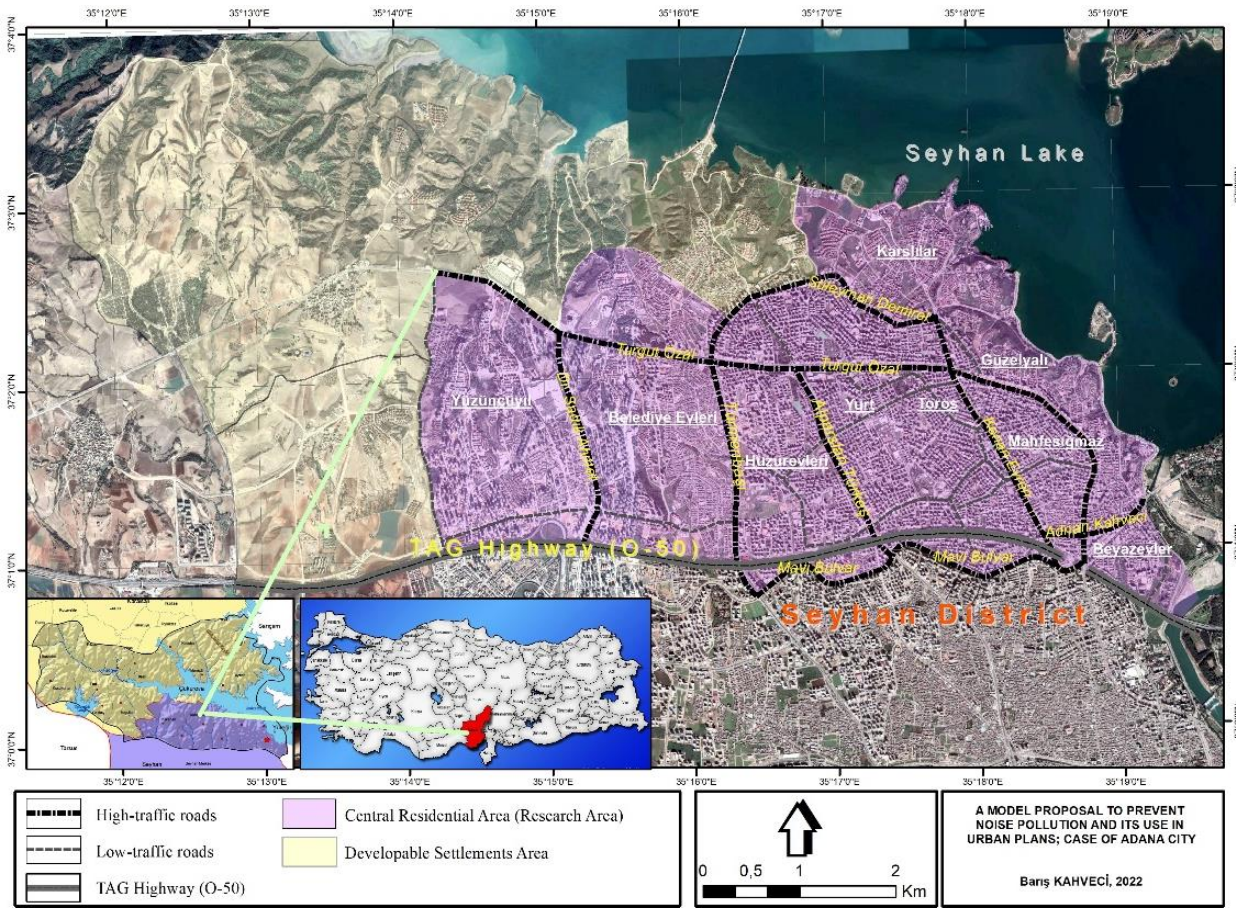

Figure 2. Location map of the research area

Table 2. Lmin, Lmax, and Leq values obtained from noise measurement points.

Measurement Point	Measurement Results								
	Daytime (L_day) (07:00-19:00) (dB(A))			Evening (L_evening) (19:00-23:00) (dB(A))			Night (L_night) (23:00-07:00) (dB(A))		
	Lmin	Lmax	Leq	Lmin	Lmax	Leq	Lmin	Lmax	Leq
K1	61.6	82.8	72.4	63.2	83.4	77.2	56.2	74.5	64.4
K2	58.9	79.6	70.5	62.4	80.5	75.4	55.4	75.2	65.4
K3	57.5	74.8	66.5	58.6	75.7	68.3	52.2	73,4	65.0
K4	56.7	76.3	69.5	57.4	75.6	68.5	50.3	70.6	64.4
K5	58.6	75.7	68.4	56.5	74.7	67.5	54.2	74.6	66.1
K6	57.5	74.8	66.5	58.6	75.7	68.3	53.6	72.4	64.8
K7	56.5	73.8	64.5	57.6	74.9	65.8	54,4	73.8	66.4
K8	62.4	76.6	69.8	60.2	78.8	70.2	59.7	73.4	63.7
K9	65.8	83.6	70.8	65.2	80.4	75.6	63.2	79.5	65.3
K10	61.1	77.4	68.5	62.8	79.4	71.4	55.8	72.6	61.5
K11	60.2	76.5	69.7	60.9	75.4	67.8	54.8	73.8	63.5
K12	59.7	75.6	68.8	61.5	77.1	69.2	55.6	72.8	62.8
K13	58.4	74.2	66.4	60.5	76.4	68.4	53.8	70.9	61.3
O1	71.9	88.0	79.4	69.4	88.6	79.8	68.6	86.2	76.4
O2	70.2	84.4	77.6	68.6	86.4	76.0	68,4	85.7	75.8

Areas	Existing Roads		
	Lday (dB(A))	Levening (dB(A))	Lnight (dB(A))
Areas predominantly characterized by noise-sensitive uses such as education, culture, and health facilities, as well as recreational and camping areas	65	60	55
Areas with a dense concentration of residences, where commercial structures coexist with noise-sensitive uses	68	63	58
Areas with a high density of businesses, where commercial structures coexist with noise-sensitive uses	70	65	60

Environmental Noise Limit Values for Road Traffic (ÇGDYY, 2010)

Method

In line with the aim of the study, the method of the research revolves around evaluating the survey. A survey was conducted to determine the social, demographic, and economic structure of individuals living in the study area and to identify perceptions, knowledge levels, experiences, opinions, and proposed solutions regarding the effects of noise pollution and its transformation into an environmental issue.

In the study area, it was determined that 363,898 people reside in the 9 neighborhoods, constituting the most densely populated region in terms of population and urban area. Based on this population, the sample size was determined as 625 with a 4% acceptable error rate at a 95% confidence interval and 400 individuals with a 5% acceptable error rate (Table 3). In this study, surveys were administered to 415 individuals.

Regarding the survey method, telephone interviews were chosen for the study, aiming for a safer and faster process during the pandemic and to ensure the participants do not have face-to-face contact with the interviewer, which is expected to yield more successful results. The survey aimed to evaluate four sections: determining the social situation of individuals living in the study area, identifying the individual's living area (neighborhood, proximity to the main road, floor of residence, etc.), determining information about noise pollution and its impact, and identifying suggestions to reduce and/or prevent the effects of noise pollution.

The questionnaire consists of 27 single-choice questions. The first five questions in the survey were designed to determine the participant's gender, age, education level, occupation, and monthly income, aiming to establish the social status and profile of the participant. Questions 6–12 investigated the participant's place of residence and their relationship with the research area. Questions 13–22 aimed to gather information about how participants are affected by noise pollution in terms of manner, time, and location. Questions 23–26 inquired about participants' knowledge and suggestions regarding the reduction and/or prevention of the effects of noise pollution. The preparation of the survey form involved reviewing studies on similar topics and evaluating them for the development of survey questions (Yücel et al., 2009; Kahveci, 2016; Yücel et al., 2015; Öner, 2018).

Before conducting the survey, participants were first informed by the interviewer about the purpose and scope of the study. Then, a clear explanation of how the survey would be conducted was provided. Surveys were implemented through personal interviews, with interviewers reading the questions and recording participants' responses on a standard form. The surveys were evaluated using the IBM-SPSS 26.0 statistical software.

In the final stage of the study, a map was created to better understand the surveys and enable spatial analysis of the survey. For the mapping, the responses to the question about the most significant environmental problem were

evaluated based on the side of the neighborhood and buildings facing the road (main road or boulevard name and side road). The main road was considered with respect to boulevards and the blocks where the first building masses were located. Two sides (right and left) were created within a 100-meter distance from the main road. The other areas of the neighborhoods were considered on the side roads.

Additionally, in the final stage, the survey outputs were evaluated in terms of individuals' environmental awareness regarding noise pollution, mapped, and results and recommendations were developed.

Table 3. Characteristics of the sample, specified limits in percentages, and sample sizes for sensitivity (Yamane, 2001)

Population Size	Sample Size for Specific Sensitivities					
	%1	%2	%3	%4	%5	%10
500	b	b	b	b	222	83
1000	b	b	b	385	286	91
1500	b	b	638	441	316	94
2000	b	b	714	476	333	95
2500	b	1.250	769	500	345	96
3000	b	1.364	811	517	353	97
3500	b	1.458	843	530	359	97
4000	b	1.538	870	541	364	98
4500	b	1.607	891	549	367	98
5000	b	1.667	909	556	370	98
6000	b	1.765	938	566	375	98
7000	b	1.842	959	574	378	99
8000	b	1.905	976	580	381	99
9000	b	1.957	989	584	383	99
10 000	5.000	2.000	1.000	588	385	99
15 000	6.000	2.143	1.034	600	390	99
20 000	6.667	2.222	1.053	606	392	100
25 000	7.143	2.273	1.064	610	394	100
50 000	8.333	2.381	1.087	617	397	100
100 000	9.091	2.439	1.099	621	398	100
⟶	10.000	2500	1111	625	400	100

Table 4. Socio-economic Status of Participants in the Survey

Category	Number	%	Category	Number	%
Gender			Age		
Female	182	43.90	Under 18 Years Old	1	0.20
Male	233	56.10	18 - 24	12	2.90
Total	415	100.00	25 – 39	98	23.60
Educational Status			40 -59	8	1,90
Illiterate	5	1.20	60 Years and Older	104	25.10
Primary School	80	19.30	No Response	2	0.50
Secondary School	38	9.20	Total	415	100.00
High School	137	33.00	Income Level (Minimum Wage Net 2300 TL in 2020)		
Undergraduate Degree	137	33.00	0 – 1500	10	2.40
Postgraduate Degree	16	3.90	1501 - 2500	64	15.40
No Response	2	0.50	2501 - 4000	154	37.10
Total	415	100.00	4001 – 8000	134	32.30
Occupation			8001 ve Üstü	48	11,60
Worker	24	5.80	No Response	5	1.20
Civil Servant	57	13.70	Total	415	100.00
Retired	103	24.80	Residential Neighborhood		
Homemaker	105	25.30	Güzelyalı	43	10.40
Academician	11	2.70	Beyazevler	43	10.40
Trader/Artisan	13	3.10	Toros	51	12.30
Private Sector Employee	48	11.60	Mahfesığmaz	36	8.70
Student	7	1.70	Karslılar	37	8.90
Freelancer	40	9.60	Huzurevleri	45	10.80
Farmer	1	0.20	Yüzüncüyıl	62	14.90
Unemployed	4	1.00	Belediyeevleri	50	12.00
Other	2	0.50	Yurt	48	11.60
Total	415	100.00	Total	415	100.00

Findings and Discussion

In previous studies conducted to determine environmental sensitivity and awareness (Yücel et al., 2006; Oğuz et al., 2011; Yeşilyurt et al., 2013; Yeşil and Turan, 2020), a method based on scoring and weighting has been followed to identify surveys and scales. However, in this study, in line with the purpose and methodology of the research, an assessment was made specifically for a single environmental issue and awareness and/or consciousness of noise pollution. Through the prepared questionnaire, analysis and inferences were made using multiple-choice questions and directly provided responses.

The survey was conducted in August-September 2020 (during the pandemic) through telephone interviews, involving a total of 415 participants. IBM SPSS Statistics v26.0 was used for evaluating the results.

The characteristics of individuals participating in the survey in terms of gender, age, education level, occupation, and monthly income are presented in Table 4.

Table 4 shows that 56.10% of the participants in the survey are male, while 43.90% are female. When participants are evaluated in terms of age groups, it is determined that the majority, with 25.10%, is 60 years and older, and 23.60% are adults aged 25-39. Of the participants, 33.00% have a high school education, and the same percentage has a university degree, making a total of 66.00% with high school and university graduates combined.

The occupations of the participants were investigated with 10 options, including 9 choices and one open-ended. Considering the possible impact of noise in the research area, it is anticipated that housewives and retired participants who spend a significant portion of the day at home would be most affected. Therefore, 25.30% of the surveys were conducted with housewives, and 24.80% with retirees, who are mostly at home during the day. Of the participants, 13.70% are civil servants, 11.90% work in the private sector, 9.60% are self-employed, 5.80% are workers, and 2.70% are academics.

17.80% of the participants earn minimum wage or below, while the majority have an income above the minimum wage. In order to make the survey more understandable and analyzable, it was aimed to have similar numbers of participants in each neighborhood. Therefore, participants are distributed with very small differences according to neighborhoods, with the lowest being 8.70% in Mağfesığmaz and the highest being 14.60% in Yüzüncüyıl.

To assess the durations of participants' residence and the potential impact of noise in the research area, Table 5 and Table 6 evaluate the participants' neighborhoods, durations of residence, and the conditions of residential facades, considering that buildings close to main roads (boulevards) are most affected by traffic-related noise.

When Table 5 is evaluated by neighborhoods and in total, it is determined that the majority of participants have a residence duration of 10 years and above, constituting 62.41% of the total.

The preference for the location where participants live, regardless of whether they are tenants or homeowners, as seen in Table 6, is determined to be "central location" with a total of 26.75%, irrespective of facade and homeownership status. Other significant reasons for preference include proximity to family at 15.66% and transportation facilities at 12.77%.

Table 7 examines the impact of the facade condition of participants' residences (main roads (boulevards) and secondary roads (streets, avenues, and side streets)) and the floor they reside on in terms of being affected by traffic noise.

Table 5. Duration of Residence According to Participants' Neighborhoods

Neighborhood		Residence Period (Years)				
		0-2	3-5	6-10	10 and above	Total
Güzelyalı	Number	1	2	10	30	43
	%	0.24	0.48	2.41	7.23	10.36
Beyazevler	Number	0	2	5	36	43
	%	0.00	0.48	1.20	8.67	10.36
Toros	Number	1	8	13	29	51
	%	0.24	1.93	3.13	6.99	12.29
Mahfesığmaz	Number	0	2	3	31	36
	%	0.00	0.48	0.72	7.47	8.675
Karslılar	Number	5	3	6	23	37
	%	1.20	0.72	1.45	5.54	8.92
Huzurevleri	Number	2	7	11	25	45
	%	0.48	1.69	2.65	6.02	10.84
Yüzüncüyıl	Number	4	15	19	24	62
	%	0.96	3.61	4.58	5.78	14.94
Belediyeevleri	Number	5	3	8	34	50
	%	1.20	0.72	1.93	8.19	12.05
Yurt	Number	4	4	13	27	48
	%	0.96	0.96	3.13	6.51	11.57
Total	Number	22	46	88	259	415
	%	5.30	11.08	21.20	62.41	100.00

Table 6. Residential preferences of participants based on homeownership and building facade conditions.

Housing Status		Primary Reason for Choice											
		CF	EF	NL	NW	RC	CL	HF	CC	SF	TF	O	T
Main Road													
Homeowner	Number	31	10	11	10	1	56	2	6	12	21	5	165
	%	15.27	4.93	5.42	4.93	0.49	27.59	0.99	2.96	5.91	10.34	2.46	81.28
Tenant	Number	5	2	0	8	7	11	0	1	2	2	0	38
	%	2.46	0.99	0.00	3.94	3.45	5.42	0.00	0.49	0.99	0.99	0.00	18.72
Total	Number	36	12	11	18	8	67	2	7	14	23	5	203
	%	17.73	5.91	5.42	8.87	3.94	33.00	0.99	3.45	6.90	11.33	2.46	100.00
Secondary Road													
Homeowner	Number	25	7	17	15	8	37	3	12	11	25	13	173
	%	11.79	3.30	8.02	7.08	377	17.45	1.42	5.66	5.19	11.79	6.13	81.60
Tenant	Number	4	4	2	7	3	7	0	4	2	5	1	39
	%	1.89	1.89	0.94	3.30	1.42	3.30	0.00	1.89	0.94	2.36	0.47	18.40
Total	Number	29	11	19	22	11	44	3	16	13	30	14	212
	%	13.68	5.19	8.96	10.38	5.19	20.75	1.42	7.55	6.13	14.15	6.60	100.00
Total													
Homeowner	Number	56	17	28	25	9	93	5	18	23	46	18	338
	%	13.49	4.10	6.75	6.02	2.17	22.41	1.20	4.34	5.54	11.08	4.34	81.45
Tenant	Number	9	6	2	15	10	18	0	5	4	7	1	77
	%	2.17	1.45	0.48	3.61	2.41	4.34	0.00	1.20	0.96	1.69	0.24	18.55
Total	Number	65	23	30	40	19	111	5	23	27	53	19	415
	%	15.66	5.54	7.23	9.64	4.58	26.75	1.20	5.54	6.51	12.77	4.58	100.00

CF: Close to Family; EF: Educational Facilities; NL: Near the Lake; NW: Near my workplace; RC: Rent is Cheap; CL: Central Location; HF: Health Facilities; CC: Calm and Clean; SF: Social Facilities; TF: Transportation Facilities; O: Other; T: Total

Table 7. Participants' housing facade condition and the impact of traffic-related noise based on the floor of residence.

Noise Discomfort Level		Floor					
		1	2 – 4	5 – 7	8 – 10	11 +	Total
Main Road (Boulevard)							
Yes	Number	34	69	40	14	27	184
	Percentage%	91.89	93.24	90.91	87.50	95.83	92.61
	Floor Percentage%	16.75	33.99	19.70	6.90	13.30	92.61
No	Number	3	5	4	2	1	15
	Percentage%	8.11	6.76	9.09	12.50	4.17	7.39
	Floor Percentage%	1.48	2.46	1.97	0.99	0.49	7.39
Total	Number	37/13*	74/28*	44/28*	16/4*	28/10*	199
	Percentage%	100.00	100.00	100.00	100.00	100.00	100.00
	Floor Percentage%	18.23	36.45	21.67	7.88	13.80	100.00
Secondary Road (Street/Alley)							
Yes	Number	49	84	25	21	7	186
	Percentage%	85.96	89.36	86.21	91.30	66.67	87.74
	Floor Percentage%	23.11	39.62	11.79	9.91	3.29	87.74
No	Number	8	10	4	2	2	26.00
	Percentage%	14.04	10.64	13.79	8.70	33.33	12.26
	Floor Percentage%	3.77	4.72	1.89	0.94	0.94	12.26
Total	Number	57/17*	94/35*	29//13*	23/12*	9/5*	212
	Percentage%	100.00	100.00	100.00	100.00	100.00	100.00
	Floor Percentage%	26.89	44.34	13.68	10.85	4.25	100.00
Total							
Yes	Number	83	153	65	35	34	370
	Percentage%	88.30	91.07	89.04	89.74	90.00	90.12
	Floor Percentage%	20.00	36.87	15.66	8.43	8.20	90.12
No	Number	11	15	8	4	3	41
	Percentage%	11.70	8.93	10.96	10.26	10.00	9.88
	Floor Percentage%	2.65	3.61	1.93	0.96	0.72	9.88
Total	Number	94/30*	168/63*	73/41*	39/16*	37/15*	411
	Percentage%	100.00	100.00	100.00	100.00	100.00	100.00
	Floor Percentage%	22.65	40.48	17.59	9.40	8.92	100.00

In the number section, values separated by '/' and presented with '*' represent the numbers of buildings with sound insulation.

Table 8. Assessment of participants' discomfort with traffic-related noise based on the housing facade condition.

Noise Discomfort Level	Number	%
While Reading a Book/Studying	26	6.27
While Working	16	3.86
While Watching TV/Movies	39	9.40
While Resting/Sleeping	293	70.60
While Sitting in the Park	5	1.20
While Taking a Walk	11	2.65
While in a Vehicle	8	1.93
Other	0	0.00
All	13	3.13
Total	415	100.00

Table 9. Participants' opinions on the most significant environmental issue based on the facade of their residences.

Konut Cephesi		The Most Significant Environmental Issue/Pollution								
		Visual	Noise	Air	Water	Waste	All	None	Other	Total
Main Road	Number	10	140	13	1	8	6	2	1	181
	%	2.41	33.73	3.13	0.24	1.93	1.45	0.48	0.24	43.62
Secondary Road	Number	33	123	20	0	10	5	13	8	212
	%	7.95	29.64	4.82	0.00	2.41	1.20	3.13	1.93	51.08
Other	Number	1	19	1	0	0	0	0	1	22
	%	0.24	4.58	0.24	0.00	0.00	0.00	0.00	0.24	5.30
Total	Number	44	282	34	1	18	11	15	10	415
	%	10.60	67.95	8.19	0.24	4.34	2.65	3.61	2.41	100.00

Table 7 has been evaluated based on the information that four participants did not provide their floor details; therefore, out of 415 participants, 411 have been considered. When Table 6 is assessed, 92.61% of the 188 participants residing on the main road side mentioned being bothered by noise, while 87.74% of the 186 participants residing on the secondary road side expressed discomfort. The highest level of discomfort with noise is observed at 93.24% among those residing on floors 2-4 and along the main road, whereas the lowest level of discomfort is noted at 66.67% among those residing on 11 floors and above.

This finding indicates that the impact of noise pollution varies based on factors such as proximity to the noise source and barriers between the noise source and the receptor, as identified through participant perspectives.

In Table 8, participants' discomfort with traffic noise is assessed based on their housing facade condition, with a total of 9 options, including an open-ended one, for what they do most when bothered by traffic noise.

When Table 8 is evaluated, it is determined that the majority of participants, with a rate of 70.60%, are bothered by traffic-related noise "while resting/sleeping."

In Table 9, participants' opinions regarding the most significant environmental issue based on the facade of their residences are queried. The purpose of the survey is to reveal differences in the option of the most important environmental issue among participants residing on the side facing the secondary road, where traffic and thus potential noise pollution are less intense.

When Table 9 is evaluated, it is found that the majority of participants, with 67.95%, consider noise pollution as the most significant environmental issue. Among participants who identify noise pollution as the most important environmental issue, it is observed that 33.73% of them reside on the main road side. Those residing along the main road consider air pollution as a secondary issue, while those living on the secondary road consider visual pollution as one of the most important problems.

In Table 10, opinions on the most significant environmental issue are queried based on participants' education level, as an addition to the survey in Table 8.

When Table 10 is evaluated, it is determined that participants, regardless of their education level, identify noise pollution as the most significant environmental issue. For participants with a bachelor's or high school education level, visual pollution is mentioned as the second most important environmental issue.

Another point to consider is that the survey was conducted during a period when stubble burning, one of the causes of air pollution in Adana Province, was taking place. Despite this, the majority of participants expressed noise pollution as the most important environmental issue. In Table 11, daily results from the Adana-Governorate air quality measurement station covering the survey period (August 15 – September 30, 2020) are provided, showing minimum, maximum, and average values.

When evaluating Table 11, it is observed that the average values of PM10 (particulate matter) and CO (Carbon Monoxide) from the National Air Quality Monitoring Network (UHKİA) Adana data are 78.40 $\mu g/m^3$ and 292.92 $\mu g/m^3$, respectively, exceeding the limit values during the specified period.

Çukurova District is one of the new and rapidly developing residential areas where construction is ongoing, featuring boulevard-like roads, a light rail system, and numerous entertainment centers. The assumption that such noise sources also affect participants has prompted the need to inquire about which noise source causes the most discomfort. Table 12 queries participants about the noise source they are most bothered by based on the facade of their residential building.

Table 10. Participants' opinions on the most significant environmental issue based on their education level.

Education Level		The Most Significant Environmental Issue/Pollution								
		Visual	Noise	Air	Water	Waste	All	None	Other	Total
Illiterate Primary School	Number	0	4	0	0	0	0	1	0	5
	%	0.00	0.96	0.00	0.00	0.00	0.00	0.24	0.00	1.20
Secondary School High School	Number	9	52	5	0	7	3	3	1	80
	%	2.20	12.50	1.20	0.00	1.70	0.70	0.70	0.20	19.30
Undergraduate Degree	Number	6	27	2	0	0	2	1	0	38
	%	1.40	6.50	0.50	0.00	0.00	0.50	0.24	0.00	9.20
Illiterate Primary School	Number	14	92	11	1	7	3	5	4	137
	%	3.37	22.17	2.70	0.20	1.70	0.70	1.20	0.96	33.00
Secondary School High School	Number	14	94	12	0	4	3	5	5	137
	%	3.37	22.65	2.90	0.00	0.96	0.70	1.20	1.20	33.00
Undergraduate Degree	Number	1	13	2	0	0	0	0	0	16
	%	0.24	3.10	0.50	0.00	0.00	0.00	0.00	0.00	3.90
Other	Number	0	0	2	0	0	0	0	0	2
	%	0.00	0.00	0.50	0.00	0.00	0.00	0.00	0.00	0.50
Total	Number	44	282	34	1	18	11	15	10	415
	%	10.60	69.95	8.19	0.24	4.34	2.65	3.61	2.41	100.00

Table 11. Adana Province air quality results (August 15 – September 30, 2020 Adana-Governorate measurement station)*

Parameter	Minimum Value (µg/m³) - Date	Maximum Value (µg/m³) - Date	Average (µg/m3)	Limit Value (µg/m3)
PM10	34.24 - 22.08.2020	141.93 - 04.09.2020	78.40	50
CO	145.75 - 07.09.2020	412.02 - 29.09.2020	292.92	10

*(UHKİA, 2022)

Table 12. The Noise Source Participants Are Most Bothered by Based on the Facade of Their Residential Building

Residential Facade		Noise Source								
		RVT	LRS	OA	EV	CS	M	A	O	T
Main Road	Number	144	1	5	8	10	5	2	6	181
	Percentage%	34.70	0.24	1.20	1.93	2.40	1.20	0.48	1.44	43.62
Secondary Road	Sayı	98	1	27	36	16	19	2	13	212
	Percentage%	23.61	0.24	6.51	8.67	3.86	4.58	0.48	3.13	51.08
Other	Sayı	17	0	0	2	1	1	0	0	22
	Percentage%	4.10	0.00	0.00	0.48	0.24	0.24	0.00	0.00	5.30
Total	Sayı	259	2	32	46	27	25	4	20	415
	Percentage%	62.41	0.48	7.71	11.08	6.51	6.02	0.96	4.81	100.00

RVT: Road Vehicle Traffic; LRS: Light Rail System; OA: Other Apartment; EV: Entertainment Venue; CS: Construction/Site; M: Market; A: All; O: Other; T Total

When Table 12 is evaluated, it is determined that 62.41% of participants are most bothered by traffic-related noise. Among the 212 participants residing in buildings facing secondary roads, 36 of them stated that they are bothered by noise from entertainment venues.

In Table 13, participants were asked about the change in traffic-related noise pollution based on the facade of their residence compared to previous years, with options "increased, decreased, no change, and I don't know." The purpose of this survey is not only to gather information about noise pollution but also to measure participants' awareness and consciousness regarding whether there has been an increase or decrease in noise pollution over the years.

When Table 13 is evaluated, it is observed that 82.20% of participants expressed the opinion that noise pollution has increased compared to previous years, while 10.60% of participants stated that there was no change in noise pollution.

In Table 14, participants were asked about the times they are most bothered by traffic-related noise. Within this context, the season, weekdays – weekends, and the time of day when they are most bothered by noise were determined. When Table 14 is evaluated, it is found that a total of 41 participants did not specify the time they were bothered by noise. The majority, 36.96% of participants, reported being bothered by noise during the spring/summer season, on weekdays, and during the daytime interval (07:00-19:00). Considering the temporal period, it is expected that the period with the least barriers between the noise source and the receptor, when doors and windows are likely to be open due to warmer temperatures, would be identified as the time when noise is most bothersome.

Table 15 queries participants about their opinions on the effects of traffic-related noise pollution on their health. The aim of this survey is to determine not only the awareness of noise but also the awareness of its effects on health and whether participants are informed about these effects.

When Table 15 is evaluated, it is observed that 40.00% of participants stated irritability as the most significant effect of traffic-related noise on their health. Other significant effects include restlessness with 18.55% and insomnia with 10.60%. According to the World Health Organization (WHO), noise levels of 35 dB(A) and above have cognitive performance effects, those above 45 dB(A) can lead to sleep disturbances, and levels above 55 dB(A) may contribute to social behavior disorders such as distress, anger, and depression. Noise levels between 65-70 dB(A) are associated with cardiovascular and psychophysiological risks (WHO, 1999). In this context, it can be inferred that 40.00% of participants were exposed to noise levels of 55 dB(A) and above.

Table 13. Temporal Change in Noise Pollution Based on Participants' Residential Facade

Residential Facade		The Direction of Change in Noise Pollution Compared to Previous Years				
		Increased	Decreased	No Change	I Don't Know	Total
Main Road	Number	150	2	22	7	181
	Percentage%	36.15	0.48	5.30	1.69	43.62
Secondary Road	Sayı	168	13	19	12	212
	Percentage%	40.48	3.13	4.58	2.89	51.08
Other	Sayı	19	0	3	0	22
	Percentage%	4.58	0.00	0.72	0.00	5.30
Total	Sayı	337	15	44	19	415
	Percentage%	81.20	3.61	10.60	4.58	100.00

Table 14. Temporal Distribution of Participants' Discomfort with Traffic-Related Noise

Noise Discomfort Level	Weekday/Weekend		All Day Time Interval				
			07:00-19:00	19:00-23:00	23:00-07:00	Fikri yok	Total
No	Weekdays	Number	9	5	2	0	16
		Percentage%	21.95	12.20	4.88	0.00	39.02
	Weekend	Number	8	6	4	3	21
		Percentage%	19.51	14.63	9.76	7.32	51.22
	Not Disturbed	Number	0	0	0	4	4
		Percentage%	0.00	0.00	0.00	9.76	9.76
	Total	Number	17	11	6	7	41
		Percentage%	41.46	26.83	14.63	17.07	100.00
Yes	All the Time						
	Weekdays	Number	4	1	1	0	6
		Percentage%	33.33	8.33	8.33	0.00	50.00
	Weekend	Number	1	3	2	0	6
		Percentage%	8.33	25.00	16.67	0.00	50.00
	Total	Number	5	4	3	0	12
		Percentage%	41.67	33.33	25.00	0.00	100.00
	Spring/Summer						
	Weekdays	Number	119	75	43	2	239
		Percentage%	36.96	23.29	13.35	0.62	74.22
	Weekend	Number	26	30	25	2	83
		Percentage%	8.07	9.32	7.76	0.62	25.78
	Total	Number	145	105	68	4	322
		Percentage%	45.03	32.61	21.12	1.24	100.00
	Fall/Winter						
	Weekdays	Number	17	12	2	1	32.00
		Percentage%	42.50	30.00	5.00	2.50	80.00
	Weekend	Number	1	4	2	1	8
		Percentage%	2.50	10.00	5.00	2.50	20.00
	Total	Number	18	16	4	2	40
		Percentage%	45.00	40.00	10.00	5.00	100.00
Total	Weekdays	Number	149	93	48	3	293
		Percentage%	35.90	22.41	11.57	0.72	70.60
	Weekend	Number	36	43	33	6	118
		Percentage%	8.67	10.36	7.95	1.45	28.43
	Not Disturbed	Number	0	0	0	4	4
		Percentage%	0.00	0.00	0.00	0.96	0.96
	Total	Number	185	136	81	13	415
		Percentage%	44.58	32.77	19.52	3.13	100.00

Table 15. Participants' Opinions on the Most Significant Effect of Noise on Their Health

Noise's Effects on Health	Number	Percentage%
Headache	36	8.67
Restlessness	77	18.55
Hearing Loss	10	2.41
Performance Decline	5	1.20
Irritability	166	40.00
Insomnia	44	10.60
Mental and Physical Fatigue	36	8.67
All	19	4.58
Not Causing Health Issues	3	0.74
Other	19	4.58
Total	415	100.00

Table 16. Participants' Opinions on Methods Implemented in Turkey to Prevent Traffic-Related Noise Pollution

The method implemented to prevent noise pollution	Number	Percentage%
Noise Offenders Being Fined	261	62.89
Ban on Loud Music Broadcasts	185	44.57
Conducting Noise Measurements	67	16.14
Imposing Speed Limits on Vehicles Due to Noise	73	17.59
Restricting Vehicle Horn Usage in Some Specific Times and Areas	123	29.63
Using Natural (Landscaping) or Artificial (Noise Barrier) Noise Screening Along Roadsides	11	2.65
Constructing Buildings with Noise-Reducing Insulation Systems	40	9.63
Other	0	0.00
Total Number of Surveys Conducted	415	

Participants selected multiple options, but the evaluation was based on the total number of surveys conducted.

Table 17. Participants' Opinions on the Most Important Measure to Be Taken to Prevent Noise from Traffic

Measures to Prevent Traffic-Related Noise	Number	Percentage%
Imposing Financial Penalties	285	68.72
Monitoring Vehicle Horn Usage	195	46.98
Conducting Speed Controls for Vehicles	139	33.49
Mandatory Sound Insulation in Residences	62	14.93
Preserving Distances Between Residences and Main Roads/Boulevards	54	13.01
Implementing Landscaping or Noise Barrier Walls Along Main Roads/Boulevards	26	6.26
Other	0	0.00
Total Number of Surveys Conducted	415	

Participants selected multiple options, but the evaluation was based on the total number of surveys conducted.

In Table 16, participants were asked about their opinions on the methods implemented in Turkey to prevent traffic-related noise pollution. Since participants were allowed to choose multiple options, each participant expressed a different number of opinions. As there were no limitations, only participants' opinions were considered, and proportional analyses were provided based on the total number of survey participants. The same calculation was applied for Table 16.

When Table 16 is evaluated, it is observed that the method of imposing fines on noise offenders is the most supported practice, with the opinions of 261 participants. The ban on loud music broadcasts received 185 opinions, and the control of horn usage in vehicles received 123 participant opinions, identifying these options as other significant measures.

In Table 17, participants' opinions on the most important measure that can be taken to prevent noise from traffic were evaluated.

When Table 17 is evaluated, participant opinions indicate that the most supported measures to be taken at the source of noise are financial penalties, with 285 responses, monitoring vehicle horn usage with 195 responses, and conducting speed controls for vehicles with 139 responses

Results and Recommendations

UNDP (United Nations Development Programme) Turkey has presented the goals for 2030 for Sustainable Cities and Communities in the 11th Article of the Global Goals for Sustainable Development report. Accordingly, the statement includes, "strengthening capacity for inclusive and sustainable urban development and planning and managing participatory, integrated, and sustainable human settlements in all countries by 2030" (UNDP Turkey, 2023). In this context, noise control should also be considered, and cities should be made livable by creating peaceful areas, thus improving the quality of life.

Nature conservation and policies for addressing environmental issues should begin with increasing individual awareness, attitudes, and sensitivity on the subject. However, efforts to determine the environmental values of specific social groups and develop measures based on the findings are limited in Turkey, as in other countries.

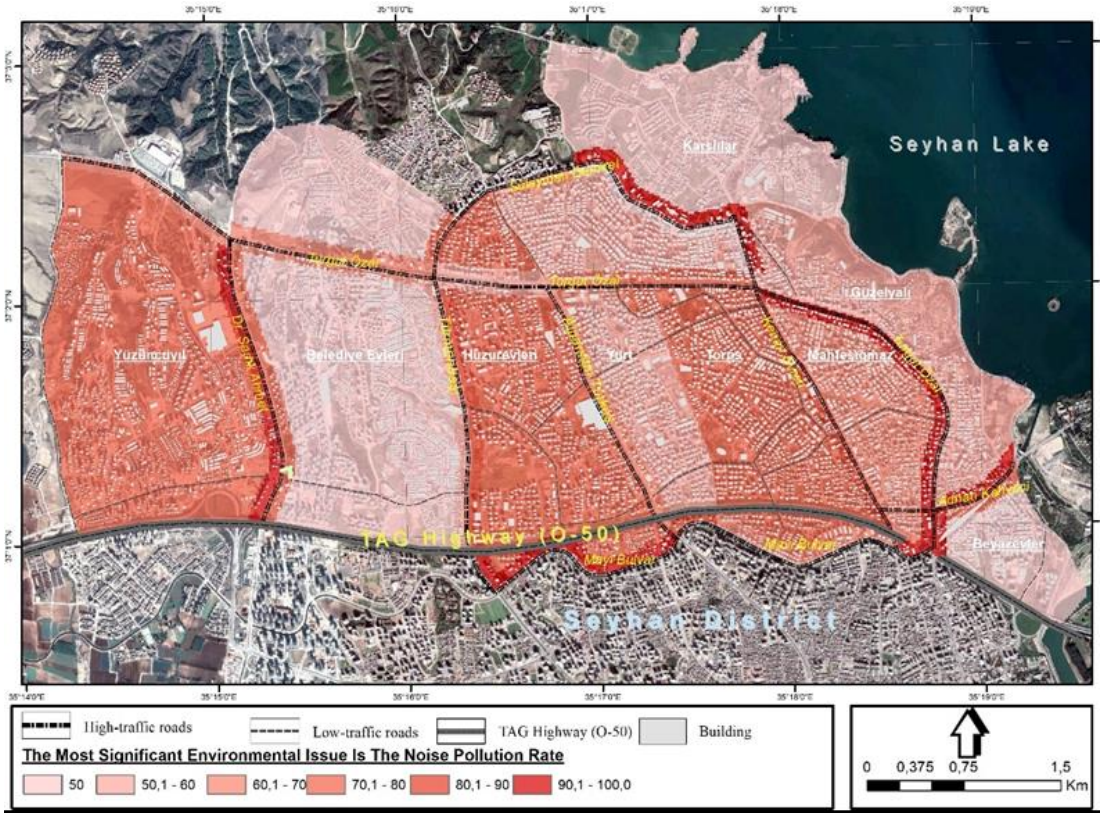

Figure 3. Spatial analysis of noise pollution awareness.

According to Yücel et al. (2006), determining the environmental awareness, attitudes, and sensitivity values of individuals in any region will provide a framework for taking measures to protect the environment and nature.

As with all environmental issues, the impact and damage caused by noise pollution, which is increasing every day, should be evaluated separately, as demonstrated in this study. According to the United States Environmental Protection Agency, the overall intensity of environmental noise doubles every decade parallel to social and industrial growth, and if unchecked, it will continue to increase uncontrollably, with the cost of reducing it in the future becoming insurmountable (Meyer, 1971, cited in Evans, 2017). In Western European countries, the Disability-Adjusted Life Years (DALY) index for traffic-related noise shows 61,000 years lost for heart disease, 45,000 years for cognitive impairment in children, 903,000 years for sleep disorders, 22,000 years for tinnitus, and 654,000 years for discomfort and anger-related disorders. This indicates that at least 1 million healthy life years are lost annually due to environmental noise related to traffic. The majority of this burden is mainly attributed to sleep disorders and discomfort caused by road traffic noise. Current assessments rank the disease burden caused by environmental noise as the second highest after air pollution (WHO European Regional Office & JRC, 2011; Hänninen et al., 2014; WHO, 2018).

Considering all these predictions and evidence, we find ourselves at a point where Dr. Robert Koch's prediction in 1910 is coming true: "One day, people will have to wage an relentless war against noise, just like cholera and plague." In this assessment, it is essential to first be aware of the encountered danger, raise awareness about preventing this danger, and act sensitively.

The existence of noise pollution from road traffic in the urban settlement area of Adana-Çukurova District, as determined by previous studies and measurements, has been proven to be known and recognized by the residents in this study (Table 9, Table 10, and Table 11). In Figure 3, a spatial analysis for noise pollution awareness has been obtained and mapped by evaluating the percentages of participants who assessed noise pollution as the most important environmental issue in the survey and considering neighborhood-road information.

When evaluating Figure 3, it is observed that individuals located near the main road (boulevard) in the research area have higher awareness of noise pollution compared to other regions. This indicates that people experiencing environmental issues have higher awareness. However, the effective solution to environmental problems lies in prevention before the environmental issue occurs. In this context, rather than increasing environmental awareness after the environmental problem arises, it is necessary to develop individuals and societies with enhanced environmental attitudes/sensitivities and use education as a means to achieve this.

In conclusion, this study is significant in terms of closely monitoring the impacts of environmental issues within the life cycle and the participation of those affected. It is important both for raising awareness in society and evaluating the participatory approach of the community in finding solutions to environmental problems. Additionally, in terms of converting the survey into a spatial analysis and usage, a unique approach has been developed in this study compared to previous works. The findings obtained will form a crucial foundation for reducing and/or preventing environmental issues such as noise pollution, and spatial analysis will play an effective role in planning measures.

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