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THE ANALYSIS OF THE LONG-TERM SUSTAINABLE PRACTISES WITH THE NOISE POTENTIAL BY USING STATISTICAL DATA, CASE STUDY: SULEYMAN DEMIREL UNIVERSITY, ISPARTA TURKEY

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Abstract

Noise level of existing noise sources are used for noise maps According to EU and Turkish Legislations. Using these sound levels, sound propagation in open space is modelled and obtained results which are basis for action plan. It is predicted that the price of the barrier which should be used for the reduction (approximately 8 dBA) of traffic noise is around EUR 400 per m^2 and the annual cost for maintenance is EUR 77 per linear m. Noise potential is a term which is created and described for this study. With this term, potential noise sources which caused to noise pollution for a specific area are considered and as a result, the action plans are created based on the noise model. The purpose of this study is to provide a sustainable noise management plan which is generated with noise potential of the area rather than an action plan which is created by existing sources for short and medium term and high-budget implementation.

In this context, the noise potential of traffic is examined in the roads in the West Campus and East Campus of Suleyman Demirel University (Isparta, Turkey) and express way which is between two campuses. And, some low-budget noise reduction proposals have been demonstrated on the model.

Keywords: noise potential, noise map, model

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1 Introduction

Noise is often defined as unwanted and offensive sound [1]. This definition is a subjective dimension. According to USEPA, there are direct links between noise and health. It has many harmful effects on the physiological and psychological health of human beings. These are hypertension, annoyance, high

stress levels, aggression, hearing loss, sleep disturbance, productivity loss and many such health problems.

Traffic noise is seen as a major source of discomfort to humans. Estimates made in some countries of the number of people highly disturbed by noise during sleep. According to a survey, between 1998 and 2003, 14 percent of the population was highly disturbed by traffic noise during sleep in the Netherlands. In addition, when it has examined the change between 1998 and 2003, it has seen that the disturbance increased from 10% to 14% [2].

The action plans based on the noise maps must be planned and implemented by considering local properties. The action plans which ignore the local capacity and requirements will not reach the goals or will give rise to uncovered costs. For example, a barrier which has designed to inhibit the distribution of the road noise without computation may reduce the noise level, but it may also cause a change in the microclimate. Furthermore, the barrier may increase the noise level at the opposite side of the barrier.

The concept of sound potential which will be revealed in this study is based on determination of the potential development of a specific sound source in a specific region. It can be provided the optimization of noise reduction investments by making plan about determined potential sources.

2 Materials and Methods

2.1 Study Area

In this study, Noise Potential has been determined for campuses of Suleyman Demirel University (SDU) in Isparta in Turkey (Figure 1). To determine the potential, the existing road traffic and the factors causing this traffic have been evaluated. The parameters that effect the traffic on the SDU campus are the location of the faculty buildings, the vehicle traffic that has been caused by the academics, students and administrative staff and the flow conditions of current roads.

In this study, it has been determined that 84% of the academics, 17,79 % of the administrative staff and 1,74% of the students contribute to road traffic on the Eastern and Western campuses of SDU. The number of students in 2000 and 2015 are seen that 5,510 and 22,107 respectively. Similarly, in 2016, it has been seen that the number of academics, administrative staff and students are 2.092, 722, and 73.464, respectively.

SDU has 15 campuses. One of these on Western campus, there are 373 academics, 92 administrative staff and 15.154 students. Other of these campuses is Eastern Campus has 1.319 academics, 373 administrative staff and 37.359 students.

As seen, it has been calculated that the number of academics, staff and students of the western and eastern campuses as 80.9 %, 60.2 % and 71.5 % of the total capacity, respectively. It has been summarized in the Table 1

Table 1 – The distribution of the number of people on campuses

	Western Campus	Eastern Campus	% of Total
Academics	373	1.319	80.9
Administrative staff	92	343	60.2
Students	15.154	37.359	71.5

Figure 1 – Study Area

In this study, the vehicular traffic of western and eastern campuses of SDU has been examined. Four faculties on Western Campus and 13 faculties on Eastern Campus are analyzed in scope of this study. Layout plan of faculty buildings are created using a GIS software. Parking areas on the campuses are also processed.

Aerial images are used to count and determine the capacity of parking areas. When this method is not applicable current legislation in Turkey is considered to determine the parking areas [3]. Current legislation indicates $20m^2$ per passenger car and $50m^2$ per heavy vehicle, however considering the parking behaviors of drivers 16 m^2 per passenger cars and 39 m^2 per heavy vehicles values are adopted in this study.

The number of vehicles registered in the Eastern and Western campus were obtained from the Vehicle Registration System of SDU. The obtained dataset includes the number of vehicles classified according to the users (academics, administrative staff and students) and the faculties.

In order to evaluate the Noise Potential (NP) it is necessary to study the movement of the vehicles in the campus area. Therefore parking behavior is monitored focusing on the average parking duration.

The observations show that the average parking duration for the Western Campus is 6 hours on the other hand for the Eastern Campus it is 4 hours. In addition, it has been determined that the occupancy rate of parking area (parked car number/total number of parking space) is 75% on the Western Campus and 80% on the Eastern Campus. Vehicles parked on the roadside were not considered in these observations..

Likewise distributions by type of total car parking spaces on campus was investigated. 95% of the total parking space is reserved for light vehicles and 5% is suitable for heavy vehicles. As a result of this study, the number of parking spaces that have been identified for the Western and Eastern campus are 1445 and 5953 units, respectively.

CadnaA software is used for the calculation of sound propagation model. The meteorological conditions have been entered into the software based on the Meteorological Statistics of General Directorate of Meteorology [4]. (Long-term 21°C and 61% of humidity)

The existing traffic potential has been considered in the calculations. Then, the synthetic propagation models have been examined in the case of traffic potential and as a result the proposals are listed for campuses of SDU.

It is expected that the evaluated noise potential will provide optimal benefits in the long-term for noise reduction action plans.

3 Results

The changes relating to the number of students, academic and administrative staff in SDU is calculated using the data of the Higher Education Institutions and ILBANK population equation. Higher Education Instution was established in Turkey with the aim of ensuring the coordination between universities. In this context, statistics related to universities in Turkey are available as open source on Higher Education Instutions web site [5]. ILBANK is tasked with making the infrastructure investments of some settlements in Turkey. Population estimation method of this institution is used in this study. This method is shown below.

$$P=((N_l/N_f)^{(1/n)}-1)*100) \quad (1)$$

$$n=t_l-t_f \quad (2)$$

$$\text{if} \quad \begin{cases} 1<P<3 & \Rightarrow P=P \\ P\leq 1 & \Rightarrow P=1 \\ P\geq 3 & \Rightarrow P=3 \end{cases}$$

$$N_a=N_y*(1+(P/100))^{(a+n)} \quad (3)$$

These parameters are shown below;
P: coefficient
N_l: Last population

N_f: First population
t_l: last year
t_f: first year
N_a: Predicted population
a: Predicticted year substract first year

The first step of the determination of the Noise Potential is to determine the increase in number of academic and administrative staff and also students. For this reason, the number of people in 2021 and 2026 were estimated via ILBANK method. Estimated and current numbers are shown in Table 2.

Table 2 – Estimated and current numbers of the affiliated people on SDU

	2016	2021	2026
Academics	2.092	2.506	2.905
Administrative staff	1.784	2.130	2.469
Students	73.464	87.720	101.691

Analyzing construction characteristics of Western and Eastern campus, it is clearly seen that southern part of the west campus and northern part of the east campus are not constructed. Depending on the expected increase in number of students, the number of academic and administrative staff will also increase. The average ratio of students to academic staff in Turkey is 45 [6]. However, this rate is 35 for SDU. Rate used in the calculations was taken as 35.The result of the modeling is shown below. Figure 2 presents the Noise Map of 2016, Figure 3 presents for 2021 and Figure 4 presents for 2026.

Figure 2 – Noise Map for 2016 of the study area

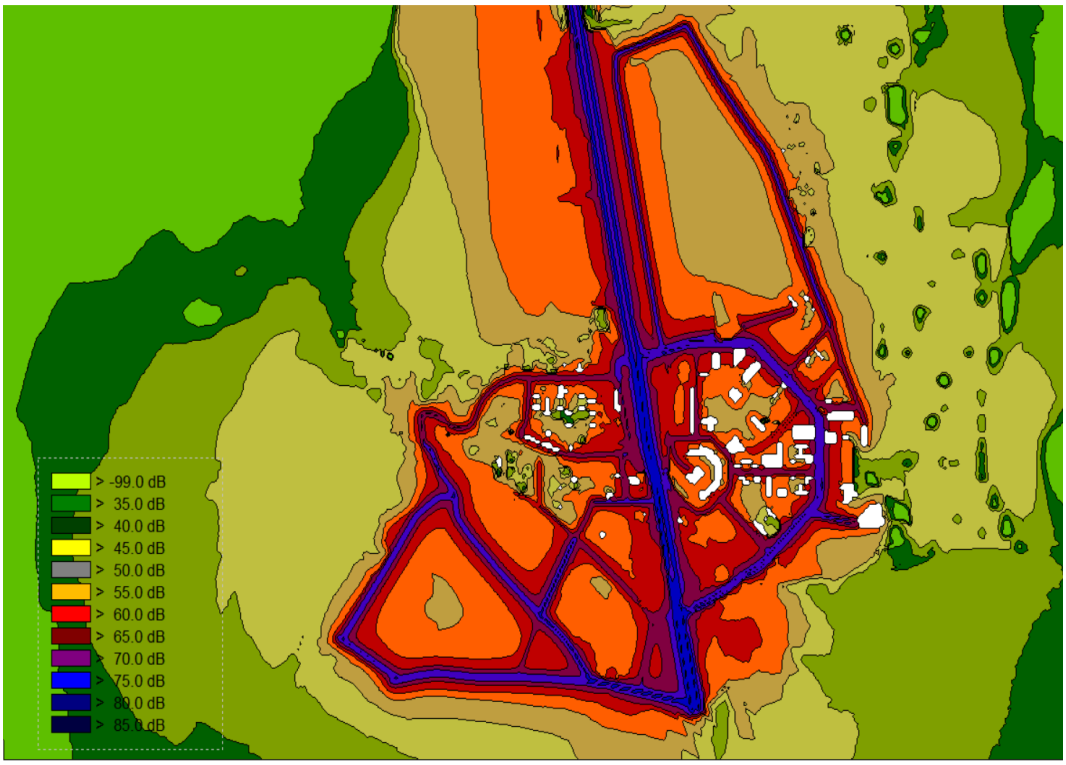

Figure 3 – Noise Map for 2021 of the study area

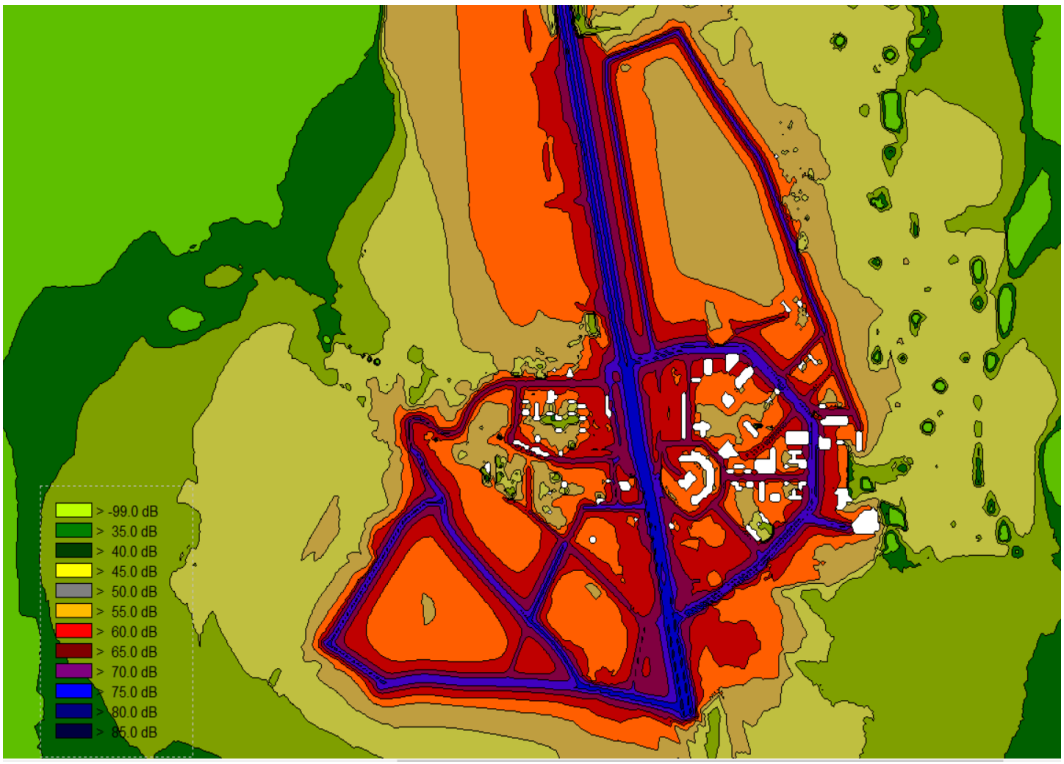

Figure 4 – Noise Map for 2026 of the study area

Facilities (classrooms, laboratories and social buildings) that would be necessary for increasing university population will be constructed in southern part of west campus and northern part of the east campus. In this context, current traffic of university was evaluated and it was modeled for possible new campus areas.
The outcome of the evaluation of the results are shown in the following table. Table 3 shows the contribution of possible changes to the current volume of traffic load on the campus and the noise potential expression

Table 3 – Comparison of noise potential with change of noise level

Change in dBA	Noise Potential
0-1	5
1-3	4
3-6	3
6-9	2
>9	1

The noise potential areas that were determined for 2021 and 2026 are shown in Figure 5 and Figure 6, respectively. According to the noise potential values, it is seen that especially the hilly areas will be affected more by the noise.

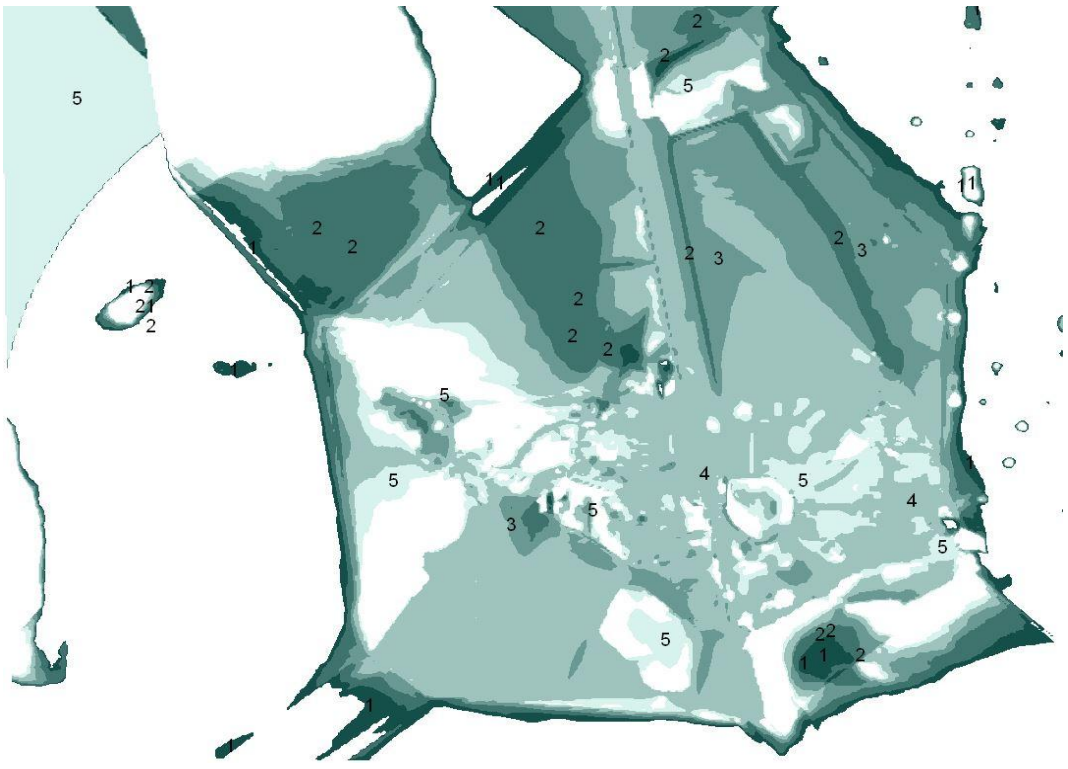

Figure 5 – Noise Potential Map for 2021 on study area

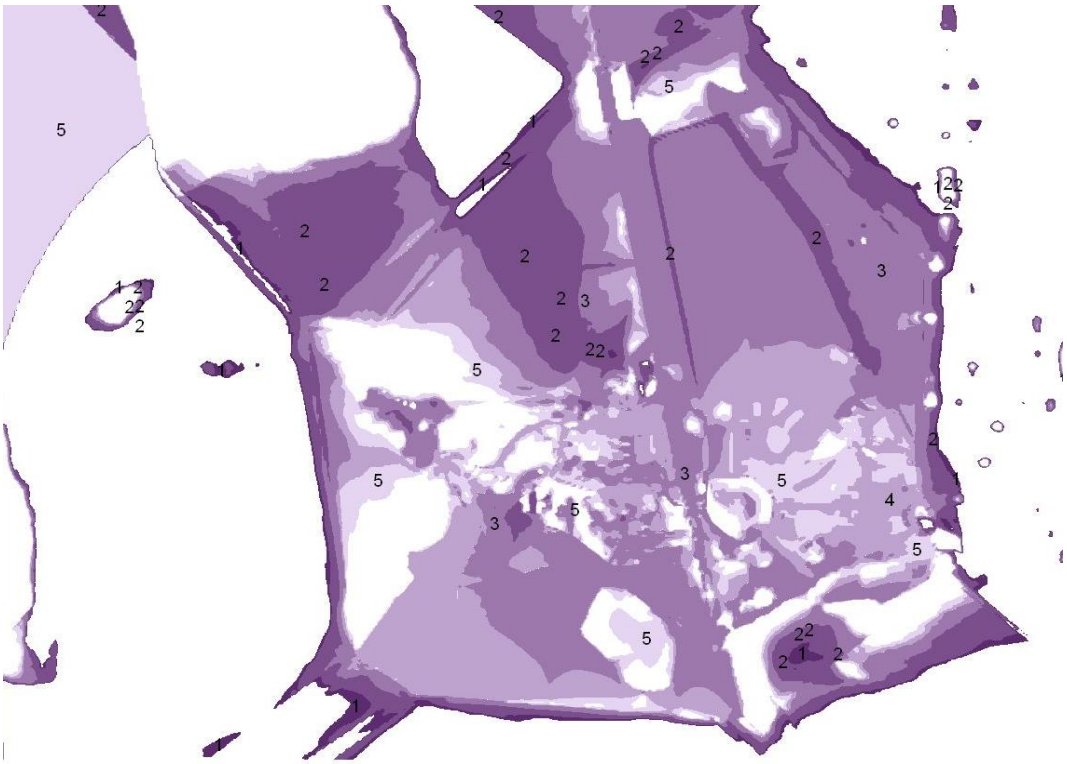

Figure 6 – Noise Potential Maps for 2026 on study area

4 Conclusions

The approach of the Noise Potential considers the change in number of students and in connection with this considers the change in land use. As known, according to both Turkish and EU Legislation, the noise maps are created in an area which has a certain population and population density and the action plans are created as a result of these maps. In this study university campus areas which have growth potential are studied. It was accepted thatwith increasing number of students and new facilities (buildings) will be required in these areas.

Road traffic is the main noise source for the campus (inter-city avenue and campus traffic flow) and noise levels are demonstrated for current situation and for future development using noise prediction models. With this study it is aimed to avoid costly corrective measures for potential problems in the future. In this context, It has been recommended that to be considered the noise potential values during the evaluation of potential growing areas.

In SDU, the classrooms, reading rooms, laboratories etc. mustn't be constructed in the areas with 1, 2 or 3 noise potential values . The areas that have noise potential value 1-2-3. Instead, the structures which are less sensitive to noise as social facilities and sport complexes etc must be made. Also, these structures must be configured so as to be an obstacle to noise source and they should be designed as a barrier for the remaining areas in behind.

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