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# Determination and Control of Noise Pollution Risk Points at the Level of Touristic Hotels

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**Abstract:** In this study, an investigation related with noise which is one of the pollution factors having negative effects on people was carried out. It was aimed to prevent suffering of people from noise pollution coming to tourism centers for holiday and recreation in Turkey and to form a standart about this subject. For this reason, studies were carried out for the determination of noise levels at a touristic hotel in Antalya, determination of exposure dosages of the people both at the hotel and living there by forming noise maps, determination of risk points, formation of a map by taking impact-distance relationship into consideration and determination of contol measures in accordance with it. It was accepted to take data in order to take the required measures all over the country. When a general evaluation was performed about these prepared noise pollution maps, it was determined that the level of noise pollution was above the value mentioned in "Regulation about the evaluation and management of environmental noise" from place to place and became to threaten the human health. As a result of noise measurements, the necessary measures to decrease this noise were specified.

**Key words:** Ecological pollution · Noise pollution · Touristic hotels · Sound measurement

## INTRODUCTION

Noise, defined as 'unwanted sound', is perceived as an environmental stressor and nuisance [1]. Noise is one of the major environmental hazards of modern world originating from a wide variety of sources, including traffic (air, road, rail), industrial facilities, or social activities [2, 3]. In the subject of protection the public health and welfare, the noise has negative effects on the environment and the people [4]. For instance, in the research carried out by Aniansson *et al.* [5], it was determined that there were alterations in the mood of the people who were subjected to 45 dB (A) and 55 dB traffic noise for 2 hours. Moreover, in the study of Marks and Griefahn [6] on 12 females and 12 males, it was observed that there were anxiety and difficulty in falling asleep in the people who were subjected to 39, 44 and 50 dBA noise levels. The noise has two effects on sleeping. One of them is difficulty in falling asleep, awakening, alterations in the sound sleep or phases of the sleep, especially reduction in the preparation of REM sleep [7]. The second one is the decay in the quality of sleep, sense of tiredness after awakening, sense of annoyance and the decrease in the performance [8, 9].

The noise pollution, which shows an increase in parallel with the improvement of the society in economical and social aspects, affects adversely the hearing health of the humans; leaves negative impression on their physiological and psychological balances; reduces their working performance; changes the quality of the environment, destroying its tranquility; disturbing and not desirable; and an unpleasant subjective structure is slightly known in country, although it is one of important environmental problem of our today [10].

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First of all, it's necessary to get information about the sources and intensity of the noise in order to struggle against noise in sites [11]. Out of order settling in the most of cities has been occurred wrong settling plan or spoiling settling up to day. There are 6 to 8 level-buildings near the 8-9 m width roads with high traffic in some cities [12]. The first step to reduce the noise levels is the preparation of noise maps. The noise maps indicate the location of the noise level where it is maximum and its level. The principle in these maps is to evaluate simply the noise levels at which people have problems. People can get information with ideal noise maps easily about the traffic plan of the city, investigation of noise elimination studies and determination of the places with high noise where noise elimination studies will be performed.

In this study, it's aimed to prevent the suffering of people from noise pollution who come for holiday and recreation to the tourism centers of Turkey. For this, the noise levels at a hotel were determined which was selected as a sample, then its noise map was prepared and formation of data was decided to take the necessary measures all over the country.

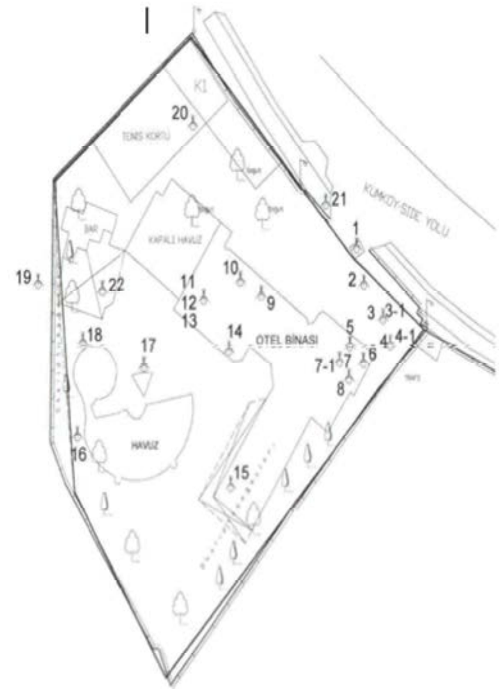


Fig. 1: The map showing the noise measurement stations

## MATERIALS AND METHODS

**Noise Measurement Stations (*Measurement Points*):** 22 measurement points were determined in a touristic hotel (five star) which is active in Kumkoy local of Manavgat district in Antalya city at the time when workplace activities and the noise are very intensive in order to map the noise levels resulting especially from the machines, equipments, employees and the guests at the hotel (Figure 1). The coordinates of measurement stations where noise measurements were carried out were determined with Magellan Spor Trak Map hand type GPS receiver (Table 1). These determined points where measurements were taken are given in Figure 1.

**The Equipment Used for Noise Measurements:** Calibrated Tetra Delta OHM 9020 trademark noise level measurement device is used for the mesurements of the noise level. The device measures in terms of Linear dBA, dBB, dBC between 20 and 130 dB and can make octave analysis having 1/1 and 1/3 filter property and Leq measurements with respect to time.

**Noise Measurements:** The noise measurements were carried out at 22 determined measurement stations (measurement points) in August and September of 2008. The measurements were performed at the source of the points where noise levels were measured and at a height of 1.5 m in the closest exposure areas.

Table 1: Coordinates of the noise measurement stations

| Number of Measurement point | Measurement point | Coordinates Y | X | Number of Measurement point | Measurement point Y | X | Coordinates |
|---|---|---|---|---|---|---|---|
| 1 | Door security | 622529.95 | 4074891.18 | 12 | 3rd Floor Room | - | - |
| 2 | Stairs of Technical Office | 622532.02 | 4074883.18 | 13 | 5th Floor Room | - | - |
| 3 | Outside of generator room | 622537.48 | 4074875.65 | 14 | Accounting office | 622493.73 | 4074868.77 |
| 4 | Inside of generator room | 622539.5 | 4074869.92 | 15 | Restaurant | 622494.28 | 4074838.85 |
| 5 | Boiler room | 622528.11 | 4074869.71 | 16 | Pool side | 622450.68 | 4074850.4 |
| 6 | Technical office | 622531.94 | 4074865.99 | 17 | Kiddy pool | 622469.55 | 4074865.26 |
| 7 | Ventillation room | 622525.19 | 4074866.18 | 18 | Slide pool | 622452.15 | 4074870.9 |
| 8 | Laundry | 622527.88 | 4074862.47 | 19 | Adjacent Parcel | 622439.47 | 4074883.84 |
| 9 | Reception | 622502.95 | 4074880.84 | 20 | Tennis Court | 622483.38 | 4074918.31 |
| 10 | Administrative office | 622496.9 | 4074883.96 | 21 | Buffets | 622521.16 | 4074900.88 |
| 11 | 1st Floor Room | 622486.47 | 4074880.05 | 22 | Animation Scene | 622457.68 | 4074882.29 |

When other studies are investigated, Koushki [13] and Baaj [14] together with KalİpcĪ and Dursun [15] performed the measurements at a height of 1.5 m while Onuu [16] and Leong [17] performed the measurements at a height of 1.2 m. Dursun and Ozdemir [18], on the other hand, performed the measurements at a height of 165-180 cm above the floor which is the level of ear. The noise measurement was carried out at the times when activities intensified (for example, at the meal time in the restaurants) and when there were no activities in the same places at the hotel.

The average of Leq values is calculated with the following equation:

$$Leq(ort) = 10_{\log}\left\{\frac{1}{100}\begin{pmatrix} t_i x10^{L_1/10} + t_2 x10^{L_2/10} + t_i x10^{L_3/10} \\ + t_i x10^{L_4/10} + t_i x10^{L_5/10} \end{pmatrix}\right\}$$

**Preparation of Noise Map:** The locations of 22 noise measurement points were processed on the map by using Netcad 4.0 GIS software programme (by entering the coordinates of measurement points) and the map showing the noise measurement points is given in Figure 1. Tetra Delta OHM 9020 Noise measurement device was used to perform the measurements at the time when activities were busy at the measurement points. The noise values and the coordinates of stations obtained as a result of measurement were entered as contour lines on the map by using Netcad 4.0 GIS software programme and the maps showing the noise pollution at the touristic facility in the morning, afternoon and evening times were prepared and are given in Figure 2, Figure 3 and Figure 4, respectively.

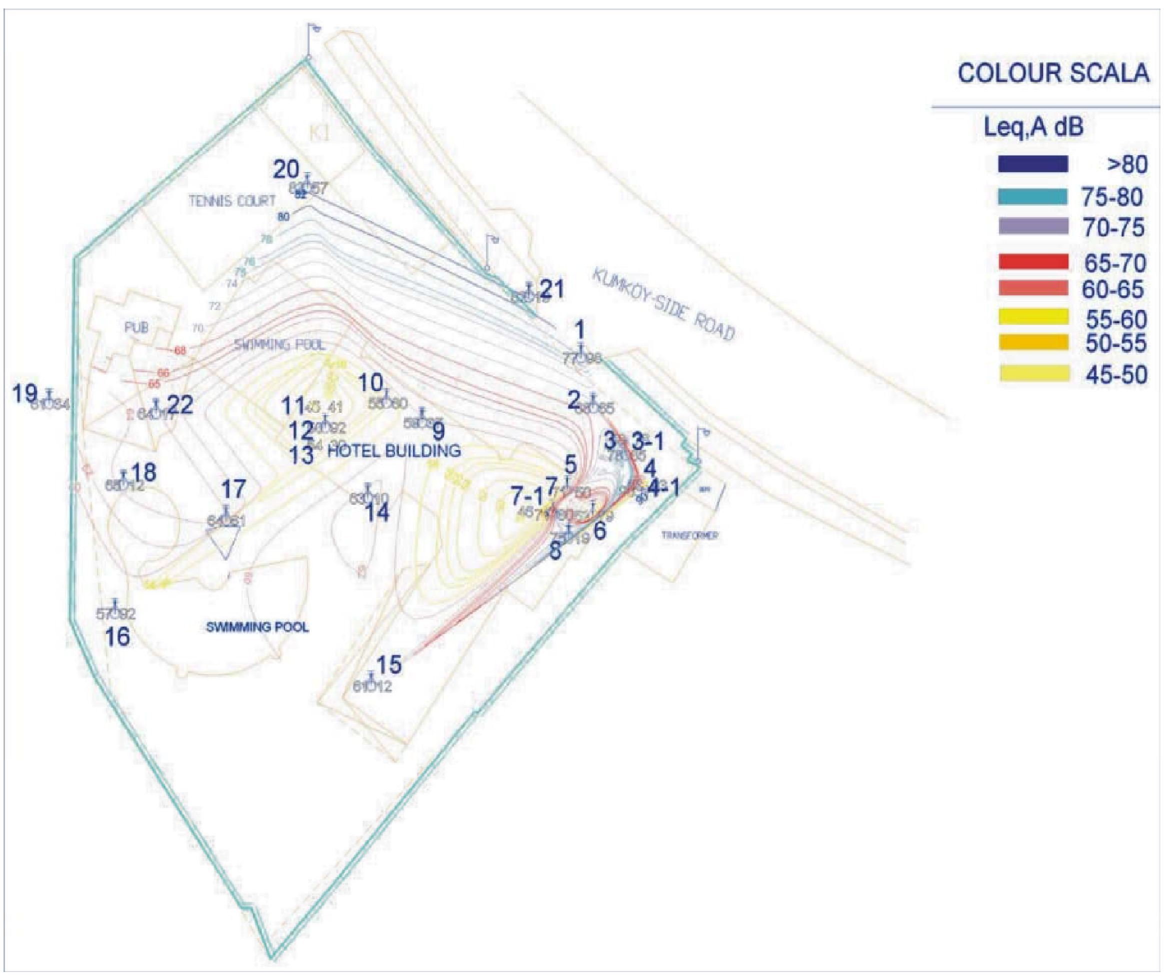


Fig. 2: Spatial Distribution of $L_{eq}$ Road Traffic Noise Levels measured between 8.00-10.00 a.m.

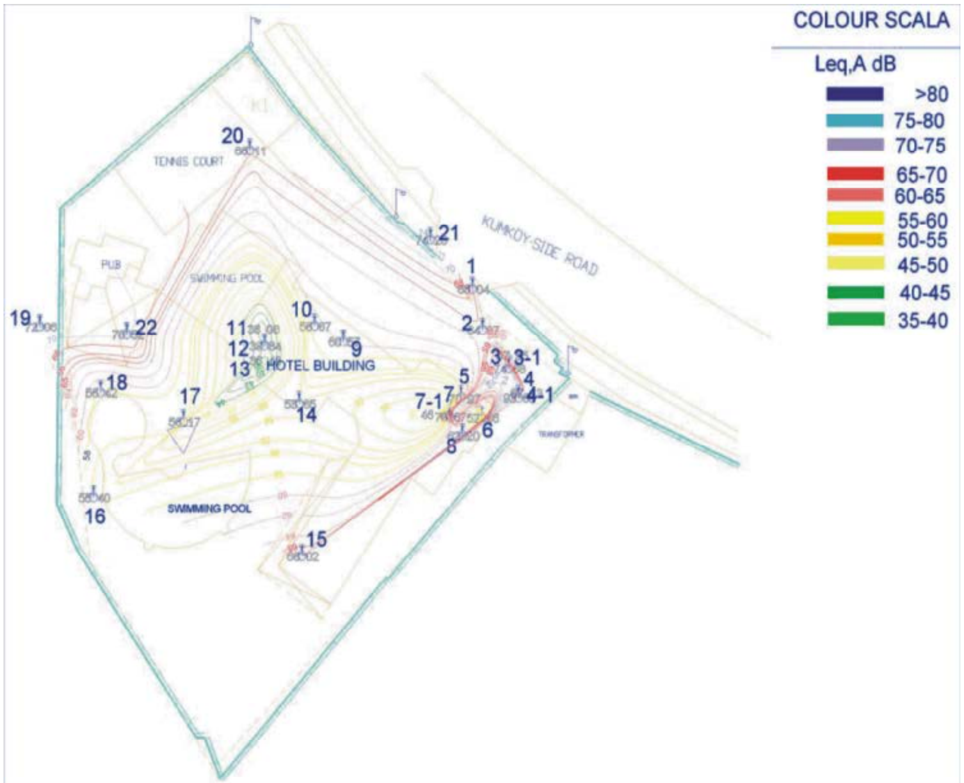


Fig. 3: Spatial Distribution of $L_{eq}$ Road Traffic Noise Levels measured between 12.00-14.00 p.m.

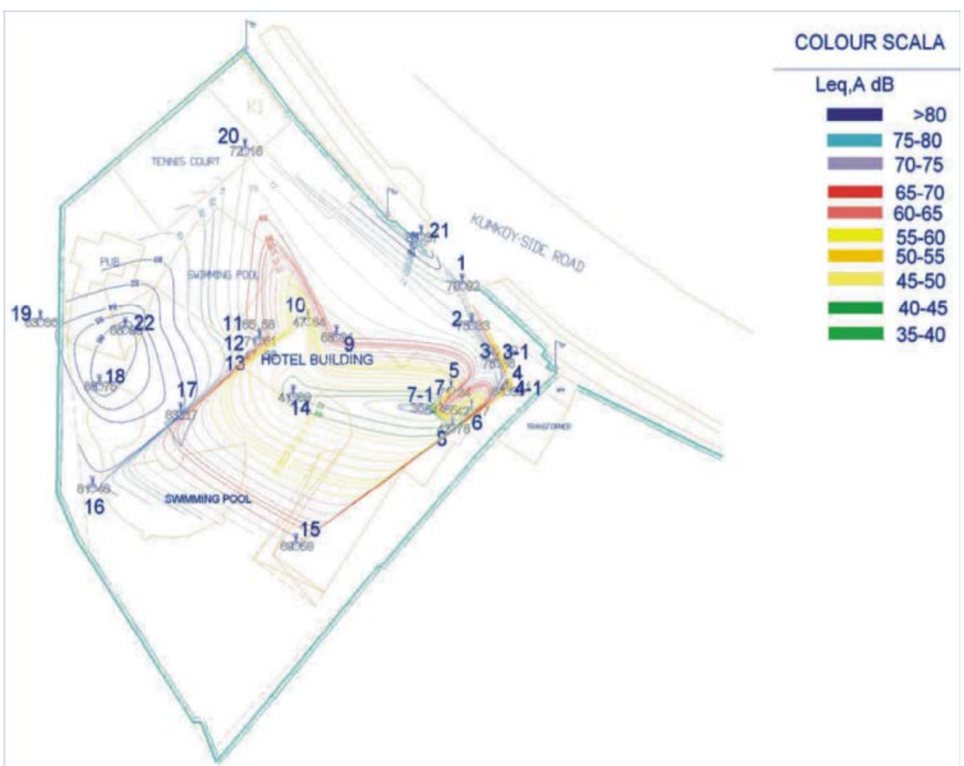


Fig. 4: Spatial Distribution of $L_{eq}$ Road Traffic Noise Levels measured between 19.00-21.00 p.m.

## RESULTS

Leq values were also measured which define the equivalent noise level as noise level. As a result of the measurements, the average of equivalent noise levels (Leq) was calculated and the noise levels of morning, afternoon and evening times at the measurement stations were determined (Table 2).

As a result of the study, the noise measurements were evaluated and the noise pollution maps were prepared (Figure 2, Figure 3 and Figure 4). According to "Regulation for the Evaluation and Management of Environmental Noise" effective in Turkey [19], while the noise level should be 35 dBA during meals in the restaurants of the hotels and holiday villages in the area of tourism sites, it was determined that the noise level was above 60 dBA as a result of the measurements at the hotel. The noise level that should be 30 dBA during sleeping in the rooms according to the regulation was quite higher than 30 dBA when compared with the results of the measurements for the 1st, 3rd and 5th floors. It can be concluded here that these noise levels obtained at evening hours were at such a level that they would prevent the recreation of people who were subjected to noise in the hotel room. Starting off from these measurements of the evening hours, it can be concluded that the noise level was at a level that would prevent the recreation of people subjected to noise in the hotel room. While the noise level in the playfields and swimming pools should be 55 dBA during the activities according to the regulation, it was observed that the noise measured in the pools and tenis court was above 55 dBA. It was also determined that the maximum noise values were obtained at the time when animation starts around the animation scene and in the entertainment center opposite the facility when the entertainment begins. Moreover, it was determined that a noise level was observed above the values mentioned in regulations as the generator starts to work in and out of the generator room.

Table 2: Noise measurements (Leq values, dBA)

| Number of station | Station point | MORNING (08.00-10.00 am) | AFTERNOON (12.00-14.00 pm) | EVENING (19.00-21.00 pm) |
|---|---|---|---|---|
| 1 | Door security | 56.5 57.2 65.9 71.4 87.7 | 71.4 65.9 58.4 67.4 56.5 | 71.4 75.4 61.6 65.9 57.2 |
| | AVERAGE | 77.98 | 65.04 | 70.92 |
| 2 | Stairs of technical office | 57.5 62.5 57.8 56.8 78.2 | 63.5 68.5 57.5 66.5 46.8 | 67.3 68.5 59.4 71.9 83.0 |
| | AVERAGE | 68.65 | 64.87 | 75.33 |
| 3 | Outside of generator room | | | |
| | (While generator is working)-1 | | | |
| | (While generator is not working)-2 | 68.5 65.5 67.2 77.3 87.7 | 79.5 81.8 66.5 71.9 46.8 | 85.9 43.3 68.5 67.3 66.5 |
| | | 62.5 57.8 56.8 55.4 59.4 | 54.6 57.6 58.6 59.5 55.4 | 54.0 51.5 43.7 48.1 43.1 |
| | AVERAGE -1 | 78.85 | 74.68 | 76.36 |
| | AVERAGE -2 | 58.78 | 57.55 | 48.39 |
| 4 | Inside of generator room | | | |
| | (While generator is working)-1 | | | |
| | (While generator is not working)-2 | 88.8 66.9 93.1 95.1 59.7 | 95.6 63.7 96.8 94.1 71.3 | 88.1 62.7 87.4 84.8 81.8 |
| | | 56.7 57.8 55.0 50.8 48.1 | 63.9 75.7 66.5 57.8 56.7 | 40.1 36.0 50.6 43.1 31.3 |
| | AVERAGE - 1 | 90.11 | 93.68 | 84.33 |
| | AVERAGE -2 | 53.93 | 67.13 | 48.11 |
| 5 | Boiler room | 78.2 64.5 46.9 40.1 59.1 | 44.2 64.2 78.4 66.7 61.5 | 77.1 63.5 44.2 60.2 74.2 |
| | AVERAGE | 71.5 | 70.97 | 71.34 |
| 6 | Technical Office | 47.5 46.4 53.5 56.7 48.3 | 56.5 55.5 47.8 53.5 48.5 | 41.5 41.9 42.4 41.9 42.3 |
| | AVERAGE | 52.79 | 52.46 | 42.17 |
| 7 | Ventillation room | | | |
| | (while ventillation is working)-1 | | | |
| | (while ventillation is not working)-2 | 52.4 51.6 71.0 76.1 76.3 | 76.3 62.8 65.9 73.3 70.5 | 69.4 66.4 61.9 51.6 48.2 |
| | | 37.5 47.3 51.8 52.3 34.9 | 33.6 31.2 34.9 57.4 42.8 | 33.1 30.5 33.3 41.6 39.5 |
| | AVERAGE -1 | 71.8 | 70.67 | 64.55 |
| | AVERAGE -2 | 46.43 | 49.45 | 36.32 |
| 8 | Laundry | 69.8 71.1 82.5 79.3 66.0 | 66.5 58.0 57.5 61.5 63.0 | 41.2 42.1 42.6 42.4 41.9 |
| | AVERAGE | 75.19 | 62.2 | 42.28 |
| 9 | Reception | 41.9 56.5 51.2 42.3 65.0 | 56.5 65.1 62.2 51.5 55.6 | 55.3 69.6 77.2 45.0 52.3 |
| | AVERAGE | 59.37 | 60.57 | 68.31 |
| 10 | Administrative office | 53.0 54.5 61.9 51.5 52.3 | 62.5 61.03 53.0 52.4 54.2 | 45.0 47.2 41.9 40.1 54.2 |
| | AVERAGE | 55.6 | 58.87 | 47.84 |

Table 2: Noise measurements - Cont. (Leq values, dBA)

| Number of Station | Station point | MORNING (08.00-10.00 am) | AFTERNOON (12.00-14.00 pm) | EVENING (19.00-21.00 pm) |
|---|---|---|---|---|
| 11 | 1st Floor Room | 58.8 38.2 43.5 40.2 35.3 | 44.5 35.2 34.9 42.5 38.9 | 63.1 78.2 76.2 32.2 42.5 |
| | AVERAGE | 50.92 | 39.84 | 71.61 |
| 12 | 3rd Floor Room | 54.4 36.3 43.5 38.2 32.3 | 35.2 34.9 41.5 38.8 38.1 | 60.1 71.2 73.2 35.0 38.9 |
| | AVERAGE | 45.41 | 38.08 | 65.58 |
| 13 | 5th Floor Room | 63.9 42.7 40.8 46.3 45.6 | 40.5 38.8 33.2 36.5 33.2 | 45.6 53.7 51.5 38.1 38.8 |
| | AVERAGE | 54.3 | 36.48 | 47.57 |
| 14 | Accounting office | 49.3 54.2 69.6 57.2 55.0 | 45.5 50.2 61.1 54.2 49.5 | 40.0 41.5 40.8 41.2 42.0 |
| | AVERAGE | 63.1 | 53.65 | 41.89 |
| 15 | Restaurant | 50.2 63.5 56.1 55.2 64.4 | 69.6 62.0 68.5 61.9 56.7 | 68.5 56.7 71.5 72.9 69.6 |
| | AVERAGE | 61.12 | 66.02 | 69.58 |
| 16 | Pool side | 61.1 50.2 51.2 57.2 62.4 | 50.2 51.5 55.5 57.0 54.1 | 48.5 58.0 73.0 71.3 88.2 |
| | AVERAGE | 57.92 | 55.4 | 81.48 |
| 17 | Kiddy pool | 65.0 63.5 58.0 67.5 63.4 | 52.0 51.5 54.0 58.0 55.6 | 78.5 88.2 77.3 52.4 73.0 |
| | AVERAGE | 64.61 | 56.17 | 83.17 |
| 18 | Slide pool | 65.0 63.5 58.0 67.5 63.4 | 52.0 51.5 54.0 58.0 55.6 | 78.5 88.2 94.2 77.0 73.0 |
| | AVERAGE | 65.12 | 56.42 | 86.73 |
| 19 | Adjacent Parcel | 48.5 43.0 52.4 49.1 71.0 | 43.0 58.0 49.0 77.0 71.2 | 82.5 48.5 58.0 73.0 88.2 |
| | AVERAGE | 61.34 | 72.06 | 83.36 |
| 20 | Tennis Court | 56.5 57.2 65.9 71.4 87.7 | 71.4 65.9 58.4 67.4 56.5 | 71.4 75.4 61.6 65.9 57.2 |
| | AVERAGE | 82.57 | 66.11 | 72.18 |
| 21 | Buffets | 58.5 57.9 68.0 72.5 88.0 | 71.4 70.5 69.5 67.5 80.5 | 86.7 85.0 84.5 82.3 83.5 |
| | AVERAGE | 82.19 | 74.28 | 85.37 |
| 22 | Animation Scene | 65.0 63.5 58.0 67.5 63.4 | 43.0 58.5 51.3 77.6 71.9 | 85.3 81.0 87.5 91.1 77.5 |
| | AVERAGE | 64.17 | 70.52 | 86.99 |

Table 3: Indoor noise level limit values [19].

| Area of usage | | Leq (dBA) | Time frame (h) |
|---|---|---|---|
| Tourism building areas | Hotel, motel, holiday village, pention and similar bedrooms | 30 | During sleeping |
| | Restaurants at the layby | 35 | Throughout the meals |
| Playfields | Fitness centers and swimming pools | 55 | During activities |

When a general evaluation was performed about the noise pollution maps, it was determined that the noise pollution level from place to place at the facility was above the value mentioned by “Regulation for the Evaluation and management of environmental noise” [19] and it threatened the human health. Indoor noise level limit values mentioned in the regulation are given in Table 3.

## SUGGESTIONS AND CONCLUSIONS

When the maps and graphs obtained with the data as a result of noise measurements at the facility were investigated, it was observed that the nois at some points were variable. It was also observed that the external factors caused the values at the facility to be above the regulation values. The facility is at the roadside of tourism way. There are no inhibitories which prevent the noise between the road and the facility. For this reason, the noise in the entrance of the facility increases with the increase in the traffic load on the road. It was suggested for the facilities on the roadside definitely to have noise barriers and landscape design not to affect the guests at the hotel with this noise. In our country, Kumbur *et al.* [21] performed noise measurements in sensitive areas such as hotels, hospitals, etc. in Mersin, which is a touristic city for 5 years. As a result of this study, it was determined that the noie levels at the hotels present in Mersin showed an increase in locations such as entrance hall and restaurants where the population of the people was very high. The results of our study are also in accordance with those of Kumbur *et al.* [21].

The noise level at evening hours increased due to entertainment activities at the hotels in the region and at the hotel selected as a sample in our study. The most closest layby is 150 meter away from the facility’s animation scene.

A noise level above the regulation values was determined indie and outside of the generator room while it works in case of power cut. Since there is no measure against noise at the present situation of the generatpr room, a noise that threatens the human health occurs.

In order to lower these high values until acceptable ones, the noise pollution should be controlled by using pyramid formed foam (a=0.30 - 1.00 noise absorption values).

The maximum value measured on the animation scne was 86.99 dBA. The animation scene is 150 meter away from the most closest layby. The effect of noise during animation demonstrations on the facilities decreases with respect to distance. When a calculation is made with respect to distance, it is found as 32.47 dBA.

Noise and thermal insulation materials are not used in the buildings due to the climate in the region where the selected facility of our study is present. For this reason, the noises inside of the buildings are easily conducted. Moreover, Buratti [22] determined in his study that the windows in the regions of hot temperate zone were kept open and the indoor noise level increased with the effect of traffic noise. The windows at the facility were constructed of double-glazing as a measure because of the complaints from the houses. Although the measures that are taken during construction of the building are more economical and easier than the ones that will be taken after construction, the employers take measures that are appropriate to their budget for the satisfaction of their guests in these days since studies were not performed about the noise in the region previously. The most preferable measures are forestation around the facility, taking the machine equipments into the protective cabinets and covering them with insulation materials. Inspite of all of these measures, the traffic load increasing in summertime, the music noise coming from the entertainment centers, noises resulting from social activities (fireworks, etc.) increase the complaints of the guests to the employers.

Since forestation is very little, its advantage to absorb the noise cannot be benefited. The negative effect of noise should be reduced by forestation and plant cover studies around the sites.

Insulation should be considered important in the construction of new buildings and the usage of noise insulation materials should be provided and supported during the construction of buildings. Moreover, it should be a compulsory to use double-glazing in the buildings. Recently, many researchers have used panel absorbers to absorb low frequency noise. For example, Kiyama *et al.* [23] found that the panel absorbers provided good noise absorption at low frequency range and the thickness of the insulating materials is inversely proportional to the frequency of sound. Nevertheless, the frequency range for noise control by this kind of absorber is still [24-27].

Whether the noise insulation materials are used or not in the buildings should be controlled carefully by the municipals. The noise level conducting from the loudspeakers which are placed out of music markets, cafe, bar and restaurants around the facility to tout the customers should be controlled. After determination of the present situation by preparation of noise maps of the region, the applications that will minimize the pollution in noise sources should be determined and accomplished [28].

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